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PRETEST REPORT FOR THE STATIC AND TRANSIENT PRESSURE TESTS OF THE 0.055 SCALE APOLLO PSTL-2 MODEL IN THE AMES RESEARCH CENTER 9 x 7 AND 11 x 11 FOOT WIND TUNNELS

NAS9-150

August 1963

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

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~~AVAILABLE TO NASA HEADQUARTERS ONLY~~

NORTH AMERICAN AVIATION, INC.
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FOREWORD

This report was prepared under NASA contract NAS9-150 by the Wind Tunnel Test Unit of Apollo Aerodynamics, Space and Information Systems Division, North American Aviation.

The basic test program including models, drawings, photographs, and run schedule is unclassified; all identifiable test results are classified CONFIDENTIAL.

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ILLUSTRATIONS

TABLES

INTRODUCTION

This report contains information necessary for the accomplishment of wind tunnel tests of the 0.055 scale Apollo PSTL-2 model in the Ames Research Center 9 x 7 and 11 x 11 foot wind tunnels. The tests are scheduled for a three week period during October and November 1963.

The primary test objective is the determination of the effects of angle of attack and Mach number changes on the distribution of static pressure over the surfaces of the Apollo payload and the forward section of the S-IVB booster. The model will include docking windows, venting ducts, CM/SM (command module, service module) umbilical housing, and RCS (reaction control system) engine pods. The engine pods will be tested in two circumferential positions. Boundary layer velocity distributions will be determined as a function of Mach number at two axial locations on the service module by means of a pair of surface mounted pitot tube rakes.

Additional test objectives concern the measurement of acoustic load levels at selected positions on the model surface. Specifically, these objectives are:

1. The determination of the spectral distribution of pressure on the spacecraft and on the LEM (lunar excursion module) adapter as a function of angle of attack and Mach number.

2. The measurement of transient pressure data at the CM/SM shoulder for the evaluation of the effect of changes in RCS engine pod location.

3. The measurement of additional acoustic load data on the command module for the refinement of heat shield loads.

The model will be tested at 13 Mach numbers in the range 0.5 to 2.4 at angles of attack from -4 to +15 degrees.

I. MODEL DESCRIPTION

The 0.055 scale PSTL-2 model represents the Apollo payload, plus the forward section of the S-IVB boost stage. The command module, service module, LEM adapter, and forward section of the S-IVB boost stage comprise one assembly when mounted on the support sting. The launch escape tower and rocket assembly can be removed and replaced with a microphone probe for the measurement of tunnel background noise. The RCS engine pods are mounted at model station X/D = 1.134 and are circumferentially displaced 90 degrees from one another. The normal orientation for the pods is such that they are displaced 7 degrees, 15 minutes from the horizontal and vertical model axes. Provision is made to test the model with the pods located on the model axes as well as in the normal position.

The nomenclature and dimensions of all major components making up the complete model are presented in this section and in Figures 1 and 2. The three configurations to be tested are made up of one basic assembly with two minor modifications as follows:

Configuration	Components	Description
1	$E_{66}T_{29}C_{42}S_7B_9I_3R_6$	Basic PSTL-2 model
2	$E_{66}T_{29}C_{42}S_{7R}B_9I_3R_6$	Basic PSTL-2 model with RCS engine pods rotated onto model horizontal and vertical axes
3	$M_1C_{42}S_7B_9I_3R_6$	Basic PSTL-2 model with microphone probe replacing $E_{66}T_{29}$ tower and escape rocket structure

Figure 3 describes the model installation in the test section. Access doors to the internally mounted scanivalves and transducers are located on the right side of the model in the service module, LEM adapter, and booster sections. The instrumentation connections between the model and the sector mounted terminal board are shielded transducer leads. Because the pressure signals from the model taps are converted to electrical outputs within the model mounted scanivalves, no manometer leads extend outside the model.

The model stress analysis is reported in the structural analysis report.[1]

FULL-SCALE DIMENSIONS

Full-scale dimensions of the model components are presented in the following listing.

Escape Motor, E_{66}	
Total length	279.67 in.
Diameter	26.00 in.
Diameter, rocket base	52.73 in.
Skirt flare angle	34.0 deg
Nose radius	2.0 in.
Nose angle	15.0 deg
Command Module, C_{42}	
Max diameter	154.0 in.
Corner radius	7.7 in.
Afterbody semi-angle	33.0 deg
Radius of heatshield	184.8 in.
Tower Structure, T_{29}	
Length	115.35 in.
Diameter of longitudinal members	3.51 in.
Diameter of cross members	2.51 in.
Service Module, S_7	
Total length	182.40 in.
Diameter	154.00 in.
Service Module, S_{7R}	
Same as S_7 with exception that RCS engine pods are rotated onto model horizontal and vertical axes	
Booster, B_9 (S-IVB stage)	
Total length	700.56 in.
Diameter	260.00 in.

[1] Structural Analysis of the 0.055-Scale Apollo Transient Pressure Model (PSTL-2). NAA S&ID SID 63-911 (July 1963).

Instrumentation Unit, I_3	
Length	36.00 in.
Diameter	260.00 in.
Rockets, R_6	
Four rocket engine pods on the service module. Location aft of command module-service module tangent point.	61.37 in.
Radial location	82.75 deg
	172.75 deg
	262.75 deg
	352.75 deg
Microphone Noise Probe, M_1	
Total length	43.17 in.
Maximum base diameter	5.86 in.
Probe diameter	1.37 in.

II. INSTRUMENTATION

The PSTL-2 model is instrumented with 230 surface static pressure taps, 18 pitot pressure tubes contained in two 9-tube boundary layer rakes, and 26 flush mounted, fast response pressure transducers, for the measurement of transient pressures. Figure 4 is an instrumentation drawing showing the location of all taps, rakes, and transducers.

The surface static taps are identified and located in Table 1. The orifice numbers listed in the table are keyed to the tap positions on the model. Figure 5 presents the orifice numbering system.

The boundary layer rakes are sketched and located in Figure 6.

The entire 248 steady pressure measurements, including the rake pitot pressures, will be sensed by a model-mounted scanivalve assembly, which is composed of two banks of six valves each. Each of the 12 valves contains 24 pin positions of which 22 are available for the measurement of model pressures. The step-drive mechanism is synchronized in such a manner that one bank of valves is recording and stepping while the other bank is waiting. This provides a more acceptable pressure settling time that is the case if all 12 valves are stepped in unison. The formats for connecting the pressure taps to each of the two scanivalve banks are presented in Tables 2 and 3. Each valve module contains one temperature compensated Statham ±12. 5 differential pressure transducer. The model surface orifices are connected to the scanivalves by means of stainless steel tubing of 0. 065 o. d. and 0. 051 I. D. The corresponding dimensions for the boundary layer rake tubes are 0. 032 o. d. and 0. 020 I. D.

Model transient pressures will be recorded by means of Photocon and Atlantic Research pick-ups. The primary instrumentation will be the Photocon cells. The Atlantic Research models are being employed as back-up instrumentation and are being located in a manner which will facilitate comparison of results obtained with the two transducer models. The two types of pick-ups are identified and located as shown in Table 4.

III. TEST PROCEDURE

With the first configuration installed in the test section, data will be obtained for several angles of attack at a single Mach number (see Table 5). This will be followed by a Mach number change, after which data will be taken for several angles of attack at the new Mach number. This process will continue until the Mach number schedule is completed, at which time a configuration change will be made and the process repeated.

Schlieren photographs will be obtained for configuration 1 at Mach number 1.15 and 1.80 at angles of attack -4, 0, 4, 9, and 15 degrees.

Several preliminary operations associated with the transient portion of the test will be necessary. All transducer cables and cable connectors will be checked by the North American Engineering Development Laboratory (EDL) and then shipped to Ames. The cables used for the PSTL-1 test at Ames will be used. Two 14-channel, extended range tape recorders will be supplied by EDL; one with FM record and one with AM record electronics. The tape required for the recorders will be supplied by NAA.

The procedures involved in conducting the transient portion of the test are as follows:

1. Determine the electrical frequency response of each Photocon measurement circuit from the tunnel to the input of the tape recorder. Disconnect the transducer cable at the junction of the Microdot and RG 58 A/U cables and inject a signal from an FC-110 calibrator. Check between the frequency limits 100 cps to 40 kcps. Reconnect the cables.

2. Pressurize the tunnel in stages, reading a d-c voltage output from each transducer at each stage. This will provide a transducer sensitivity calibration in volts/psi and will check for possible malfunction of transducers.

3. During the calibration runs for the determination of tunnel background noise levels, data will be gathered in three stages. With the noise probe installed on the model (configuration 3), one minute of electrical calibration signal will be recorded at 3 volts and 500 cps for the noise probe and 1 volt at 400 cps for the transducer. One minute of data recording system noise

will be recorded and 90 seconds of air-on noise probe and model transducer data will be recorded for the conditions listed in Table 5. During tunnel noise level runs, the noise probe output will be recorded on a channel normally used for one of the transducers now covered by the probe support cone.

4. During the actual data runs, data will be gathered as described in procedure number 3 above, with the exception that the electrical calibration signal will be 1 volt at 400 cps.

There will be no separate runs for transient and steady state pressure portions of the test; steady state data will be recorded, via the scanivalve/ Beckman system, simultaneously, with the tape recording of the transient data.

IV. DATA REDUCTION

NOMENCLATURE

Model Components

CM	Command Module
SM	Service Module
LEM	Lunar Excursion Module
RCS	Reaction Control System

Model Component Coding

E_{66}	Escape Motor
C_{42}	Command Module
T_{29}	Tower Structure
S_7	Service Module
S_{7R}	Service Module
B_9	Booster
I_3	Instrumentation Unit
R_6	Rocket Engine Pods
M_1	Microphone Noise Probe

Model Instrumentation

A_1 to A_6	Atlantic Research Transducers numbers 1 to 6
P_1 to P_{20}	Photocon Transducers numbers 1 to 20
R_{11} to R_{29}	Boundary Layer Rake Orifice numbers 11 to 29

Model Coordinates

D	Maximum diameter of command module, 8.47 inches, model scale
X	Distance aft of command module actual nose, model scale inches
X_a	Full scale vehicle station decreasing aft from value X_a = 1133.733 at command module actual nose, full scale inches
ϕ	The angle used for locating pressure taps. It increases positively toward the +Y axis from zero at the -Z axis, degrees. See Figures 1 and 2 for model axis system.

Transient Pressures

$\bar{P}$	Root-mean-square value of fluctuating pressure, lb/in.^{2}
SPL	Sound pressure level, db, re, 0.0002 dynes/cm^2

STEADY-STATE PRESSURES

The raw pressure data will be reduced to coefficient form according to the equation:

$$C_p = \frac{P - P_o}{q_o}$$

in which

C_p = Pressure coefficient at a given tap location

P = Pressure at the given tap location, lb/ft^2

P_o = Free stream static pressure, lb/ft^2

q_o = Free stream dynamic pressure, lb/ft^2

The steady-state pressure data will be reduced to coefficient form by Ames personnel and will be presented to North American via card or tape medium. The listing format on the tape should be such that the data for all pressure taps at a given model station will appear on a single card. This format differs from one in which data from taps at several model stations' appears consecutively on the tape or together on a single card. For instance, orifice numbers 91, 93, 95, 97, and 99 should appear in succession on the tape, rather than orifice numbers 91, 101, 111, 121, 131 (see Table 1).

A sample of the format for the final steady-state pressure coefficient listing is presented in Table 6.

TRANSIENT PRESSURES

All recording, reduction, and analysis of the unsteady pressure data will be performed by NAA personnel. The following paragraphs briefly outline the data reduction stages.

Background Noise

The overall and 1/3-octave band levels of fluctuating pressure will be determined and recorded as $\overline{P}$ (psi rms) and SPL (sound pressure level, db, re, 0.0002 dynes/cm^2).

Boundary Layer Noise

1. The overall and 1/3-octave band pressure levels will be determined. The pressure power spectral density will be computed for selected test conditions.

2. The effect of background noise levels on the measured boundary layer levels will be determined and appropriate corrections applied as necessary.

3. Sound pressure levels at 1/3-octave band frequencies for all Mach numbers at zero angle of attack will be plotted. Overall sound pressure levels will be plotted against body station for all Mach numbers.

Data Analysis and Translation of Sub-Scale Model Data to Full-Scale Model

From analysis of the model data, and by use of the following scaling relationships, the amplitude and frequency distribution of pressures on the spacecraft and on the LEM adapter will be determined as a function of

Mach number and angle of attack. The full-scale flight condition will be computed at all Mach numbers for α = 0 degree, as will the conditions of M and α which produce maximum levels.

$$\text{Frequency: } F_2 = F_1 \,(d_1/d_2)\,(v_2/v_1)$$

$$\text{1/3-octave band levels: } \overline{P}_2 = \overline{P}_1 \,(q_2/q_1)$$

in which

F = frequency, cps

(d_1/d_2) = model scale factor (0.055)

v = free stream velocity, ft/sec

q = dynamic pressure, lb/in.^{2}

$\overline{P}$ = root-mean-square pressure, lb/in.^{2}

1 = subscript denoting sub-scale model value

2 = subscript denoting full-scale model value

V. DATA TRANSMITTAL

Four copies of the final tabulated data are required and should be distributed as follows:

1. Letter of transmittal and (2) copies of the data (one copy reproducible) including Tunnel Run Log, to:

   North American Aviation, Inc.
   Space and Information Systems Division
   12214 Lakewood Boulevard
   Downey, California
   Attn: Mr. Edwin C. Allen, Dept. 695-223

2. Letter of transmittal and (1) copy of the data including Tunnel Run Log to:

   NASA Manned Spacecraft Center
   Apollo Spacecraft Project Office
   Office City, Gulf Freeway
   Houston, Texas
   Attn: Mr. Calvin H. Perrine

3. Letter of transmittal and (1) copy of the data including Tunnel Run Log to:

   NASA Manned Spacecraft Center
   Spacecraft Technology Division
   Aerodynamic Branch
   Houston, Texas
   Attn: Mr. W. C. Moseley, Jr.

North American Aviation, Inc. has a contractual obligation to provide NASA with a preliminary report containing tabulated data, thirty days after the completion of each test. In order to meet this requirement it will be necessary to have the complete set of data noted in (1) above delivered to NAA not later than ten working days after the completion of the test. In addition to the tabulated data, it is desired that tabulated data IBM cards containing the same information be made available to NAA at that time. A copy of the raw data in magnetic tape form is also required.

Table 1. Location of Static Pressure Instrumentation

Orifice Station	X/D	φ				
		0°	45°	90°	135°	180°
		Model Orifice Numbers				
0	0	01				
1	0.090	11	13	15	17	19
2	0.180	21	23	25	27	29
3	0.260	31	33	35	37	39
4	0.340	41	43	45	47	49
5	0.430	51	53	55	57	59
6	0.500	61	63	65	67	69
7	0.560	71	73	75	77	79
8	0.670	81	83	85	87	89
9	0.695	91	93	95	97	99
10	0.720	101	103	105	107	109
11	0.750	111	113	115	117	119
12	0.880	121	123	125	127	129
13	0.950	131	133	135	137	139
14	1.100	141	143	145	147	149
15	1.200	151	153	155	157	159
16	1.320	161	163	165	167	169
17	1.400	171	173	175	177	179
18	1.500	181	183	185	187	189
19	1.600	191	193	195	197	199
20	1.700	201	203	205	207	209
21	1.800	211	213	215	217	219
22	1.950	221	223	225	227	229
23	2.100	231	233	235	237	239
24	2.160	241	243	245	247	249
25	2.220	251	253	255	257	259
26	2.400	261	263	265	267	269
27	2.600	271	273	275	277	279
28	2.800	281	283	285	287	289
29	3.000	291	293	295	297	299
30	3.200	301	303	305	307	309
31	3.400	311	313	315	317	319
32	3.600	321	323	325	327	329
33	3.800	331	333	335	337	339
34	4.000	341	343	345	347	349

Table 1. Location of Static Pressure Instrumentation (Cont)

Orifice Station	X/D	ϕ				
		0°	45°	90°	135°	180°
		Model Orifice Numbers				
35	4.130	351	353	355	357	359
36	4.190	361	363	365	367	369
37	4.250	371	373	375	377	379
38	4.380	381	383	385	387	389
39	4.500	391	393	395	397	399
40	4.700	401	403	405	407	409
41	4.900	411	413	415	417	419
42	5.100	421	423	425	427	429
43	5.300	431				
44	5.500	441				
45	5.700	451				
46	5.900	461				
47	6.100	471				
48	6.300	481				
49	6.500	491				
50	6.700	501				
51	6.900	511				
52	7.100	521				
53	7.300	531				
54	7.500	541				
55	7.700	551				
56	7.900	561				
57	8.100	571				
58	8.300	581				
59	8.500	591				
60	8.700	601				
61	8.900	611				

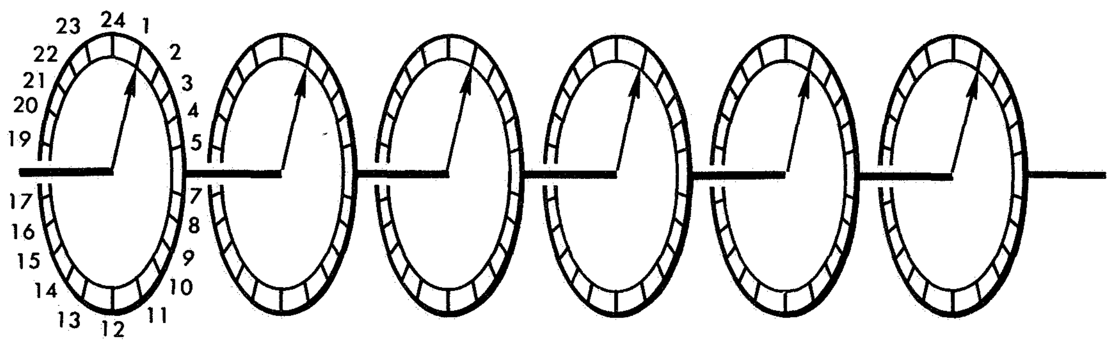


Table 2. Connection Format For Scanivalve Number 1

Switch Position	Valve Module Number					
	1	2	3	4	5	6
	Orifice Numbers					
1	01	11	13	15	17	19
2	33	35	37	39	41	43
3	57	59	61	63	65	67
4	81	83	85	87	89	91
5	105	107	109	111	113	115
6	129	131	133	135	137	139
7	153	155	157	159	161	163
8	177	179	181	183	185	187
9	201	203	205	207	209	211
10	225	227	229	231	233	235
11	249	251	253	255	257	259
12	273	275	277	279	281	283
13	297	299	301	303	305	307
14	321	323	325	327	329	331
15	345	347	349	351	353	355
16	369	371	373	375	377	379
17	393	395	397	399	401	403
18	417	419	421	423	425	427
19	481	491	501	511	521	531
20	601	611	R11	R12	R13	R14
21	R22	R23	R24	R25	R26	R27

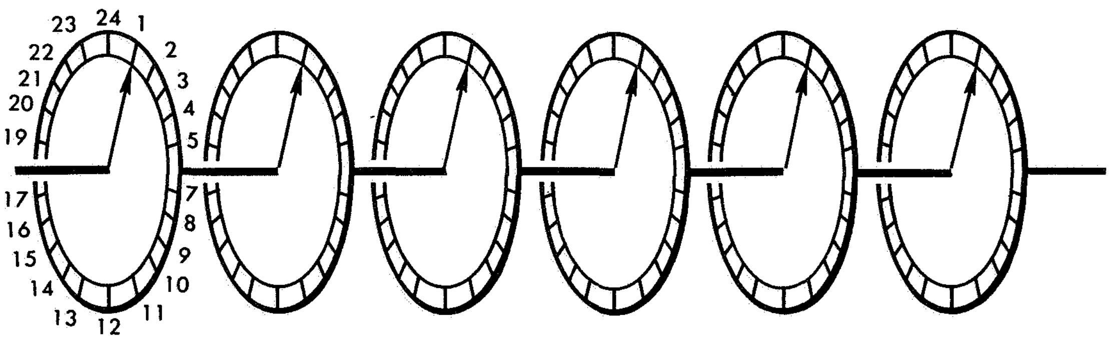


Table 3. Connection Format For Scanivalve Number 2

Switch Position	Valve Module Number					
	1	2	3	4	5	6
	Orifice Numbers					
1	21	23	25	27	29	31
2	45	47	49	51	53	55
3	69	71	73	75	77	79
4	93	95	97	99	101	103
5	117	119	121	123	125	127
6	141	143	145	147	149	151
7	165	167	169	171	173	175
8	189	191	193	195	197	199
9	213	215	217	219	221	223
10	237	239	241	243	245	247
11	261	263	265	267	269	271
12	285	287	289	291	293	295
13	309	311	313	315	317	319
14	333	335	337	339	341	343
15	357	359	361	363	365	367
16	381	383	385	387	389	391
17	405	407	409	411	413	415
18	429	431	441	451	461	471
19	541	551	561	571	581	591
20	R15	R16	R17	R18	R19	R21
21	R28	R29				

Table 4. Location of Transient Pressure Instrumentation

Measurement Number	Axial Location		ϕ deg	Recorder	
	X	X_a		Mode	Channel
P1	3.261	1074.43	180	FM	1
P2	3.261	1074.43	0	FM	2
P3	5.251	1038.25	180	FM	3
P4	5.251	1038.25	255	FM	4
P5	5.251	1038.25	0	FM	5
P6	6.945	1007.45	180	FM	6
P7	6.945	1007.45	0	FM	7
P8	8.555	978.18	180	FM	8
P10	10.672	939.69	180	FM	9
P11	10.672	939.69	135	FM	10
P13	17.194	821.10	180	FM	11
P15	19.396	781.07	180	FM	12
P20	36.590	468.44	180	FM	13
VOICE	—	—	—	FM	14
P9	8.555	978.18	135	AM	1
P12	15.754	847.28	180	AM	2
P14	17.194	821.10	0	AM	3
P16	19.396	781.07	0	AM	4
P17	21.514	742.56	180	AM	5
P18	27.612	631.68	180	AM	6
P19	34.388	508.48	180	AM	7
A1	5.251	1038.25	75	AM	8
A2	8.555	978.18	0	AM	9
A3	8.555	978.18	315	AM	10
A4	10.672	939.69	0	AM	11
A5	10.672	939.69	315	AM	12
A6	27.612	631.68	270	AM	13
VOICE	—	—	—	AM	14
Noise Probe	—	—	—	FM/AM	1

Note: P - Photocon Transducers
A - Atlantic Research Transducers

Table 5. Run Schedule

Run	Configuration	M	α
1	$1\text{-}(E_{66}T_{29}C_{42}S_7B_9I_3R_6)$	0.50	A
2		0.70	B
3		0.80	A
4		0.85	B
5		0.90	A
6		0.95	A
7		1.00	B
8		1.15*	B*
9	$1\text{-}(E_{66}T_{29}C_{42}S_7B_9I_3R_6)$	1.35	A
10	$2\text{-}(E_{66}T_{29}C_{42}S_{7R}B_9I_3R_6)$	0.80	A
11		0.85	B
12		0.90	A
13	$2\text{-}(E_{66}T_{29}C_{42}S_{7R}B_9I_3R_6)$	0.95	A
14	$3\text{-}(M_1C_{42}S_7B_9I_3R_6)$	0.70	0°
15		0.80	
16		0.90	
17		1.00	
18	$3\text{-}(M_1C_{42}S_7B_9I_3R_6)$	1.35	0°
19	$1\text{-}(E_{66}T_{29}C_{42}S_7B_9I_3R_6)$	1.55	A
20		1.80*	B*
21		2.00	A
22		2.40	A
23	$2\text{-}(E_{66}T_{29}C_{42}S_{7R}B_9I_3R_6)$	1.55	A
24	$2\text{-}(E_{66}T_{29}C_{42}S_{7R}B_9I_3R_6)$	2.00	A
25	$3\text{-}(M_1C_{42}S_7B_9I_3R_6)$	1.55	0°
26		1.80	
27		2.00	
28	$3\text{-}(M_1C_{42}S_7B_9I_3R_6)$	2.40	0°

* Schlieren Photos at α = -4, 0, 4, 9, 15 degrees

α Schedule

A: α = 0, 2, 4, 6, 9, 12, 15 degrees

B: α = -4, 0, 2, 4, 6, 9, 12, 15 degrees

Table 6. Steady-State Pressure Coefficient Listing Format

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Date	Corr	Tunnel	Test	Phase	Run	M	q	$R_e \times 10^{-6}$	Config	α	β								
X/D \ Ø	0°	45°	90°	135°	180°		X/D \ Ø	0°	45°	90°	135°	180°		X/D \ Ø	0°	45°	90°	135°	180°
0	Cp001						1.200	Cp151	Cp153	Cp155	Cp157	Cp159		3.000	Cp291	Cp293	Cp295	Cp297	Cp299
0.090	Cp011	Cp013	Cp015	Cp017	Cp019		1.320	Cp161	Cp163	Cp165	Cp167	Cp169		3.200	Cp301	Cp303	Cp305	Cp307	Cp309
0.180	Cp021	Cp023	Cp025	Cp027	Cp029		1.400	Cp171	Cp173	Cp175	Cp177	Cp179		3.400	Cp311	Cp313	Cp315	Cp317	Cp319
0.260	Cp031	Cp033	Cp035	Cp037	Cp039		1.500	Cp181	Cp183	Cp185	Cp187	Cp189		3.600	Cp321	Cp323	Cp325	Cp327	Cp329
0.340	Cp041	Cp043	Cp045	Cp047	Cp049		1.600	Cp191	Cp193	Cp195	Cp197	Cp199		3.800	Cp331	Cp333	Cp335	Cp337	Cp339
0.430	Cp051	Cp053	Cp055	Cp057	Cp059		1.700	Cp201	Cp203	Cp205	Cp207	Cp209		4.000	Cp341	Cp343	Cp345	Cp347	Cp349
0.500	Cp061	Cp063	Cp065	Cp067	Cp069		1.800	Cp211	Cp213	Cp215	Cp217	Cp219		4.130	Cp351	Cp353	Cp355	Cp357	Cp359
0.560	Cp071	Cp073	Cp075	Cp077	Cp079		1.950	Cp221	Cp223	Cp225	Cp227	Cp229		4.190	Cp361	Cp363	Cp365	Cp367	Cp369
0.670	Cp081	Cp083	Cp085	Cp087	Cp089		2.100	Cp231	Cp233	Cp235	Cp237	Cp239		4.25	Cp371	Cp373	Cp375	Cp377	Cp379
0.695	Cp091	Cp093	Cp095	Cp097	Cp099		2.160	Cp241	Cp243	Cp245	Cp247	Cp249		4.38	Cp381	Cp383	Cp385	Cp387	Cp389
0.720	Cp101	Cp103	Cp105	Cp107	Cp109		2.220	Cp251	Cp253	Cp255	Cp257	Cp259		4.50	Cp391	Cp393	Cp395	Cp397	Cp399
0.750	Cp111	Cp113	Cp115	Cp117	Cp119		2.400	Cp261	Cp263	Cp265	Cp267	Cp269		4.70	Cp401	Cp403	Cp405	Cp407	Cp409
0.880	Cp121	Cp123	Cp125	Cp127	Cp129		2.600	Cp271	Cp273	Cp275	Cp277	Cp279		4.90	Cp411	Cp413	Cp415	Cp417	Cp419
0.950	Cp131	Cp133	Cp135	Cp137	Cp139		2.800	Cp281	Cp283	Cp285	Cp287	Cp289		5.10	Cp421	Cp423	Cp425	Cp427	Cp429
1.100	Cp141	Cp143	Cp145	Cp147	Cp149														
DATA FOR TAPS AT Ø = 0°																			
X/D	5.300	5.500	5.700	5.900	6.100	6.300	6.500	6.700	6.900	7.100	7.300	7.500	7.700	7.900	8.100	8.300	8.500	8.700	8.900
Cp	Cp431	Cp441	Cp451	Cp461	Cp471	Cp481	Cp491	Cp501	Cp511	Cp521	Cp531	Cp541	Cp551	Cp561	Cp571	Cp581	Cp591	Cp601	Cp611
RAKE DATA																			
y/L	0.020	0.080	0.140	0.200	0.300	0.400	0.550	0.700	0.900										
R1	Cp11	Cp12	Cp13	Cp14	Cp15	Cp16	Cp17	Cp18	Cp19										
R2	Cp21	Cp22	Cp23	Cp24	Cp25	Cp26	Cp27	Cp28	Cp29										

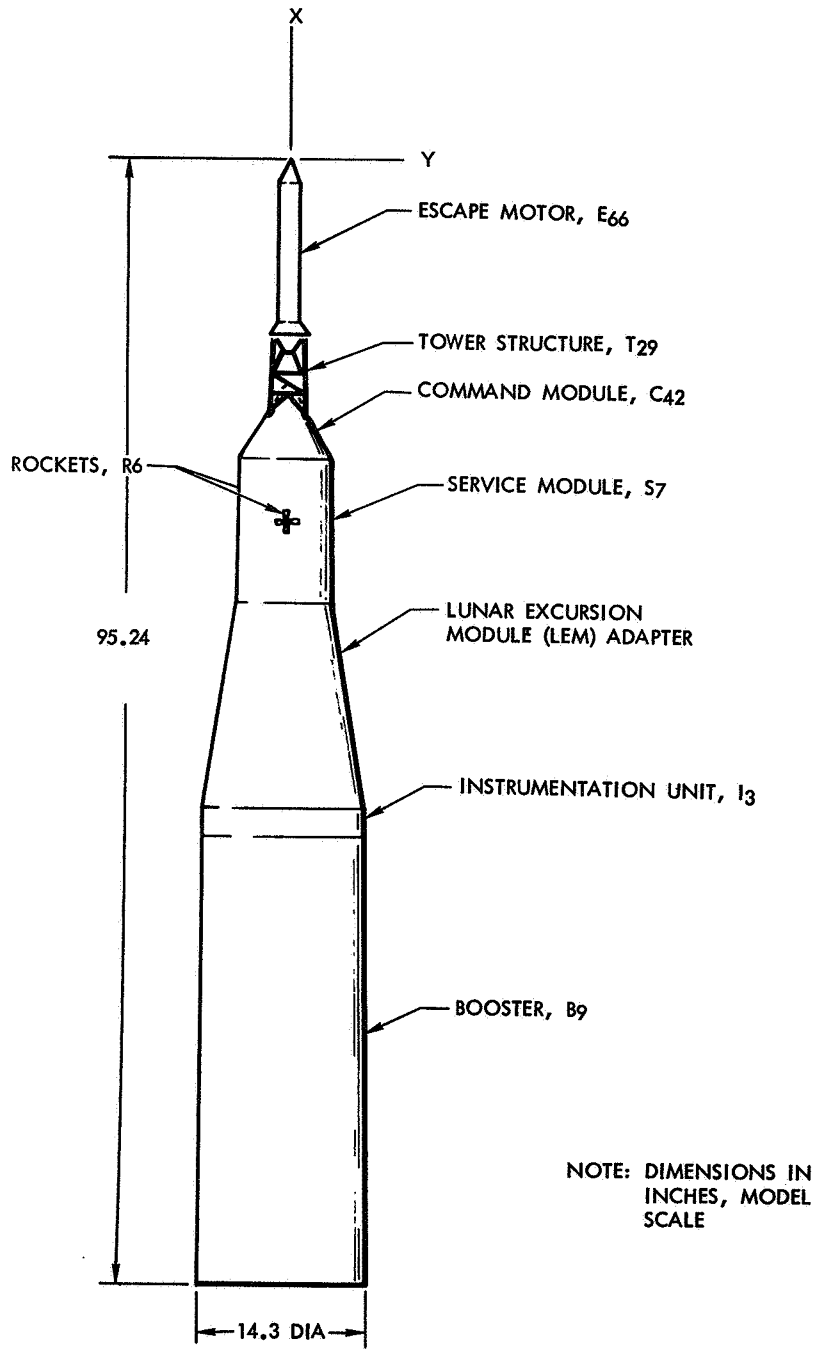
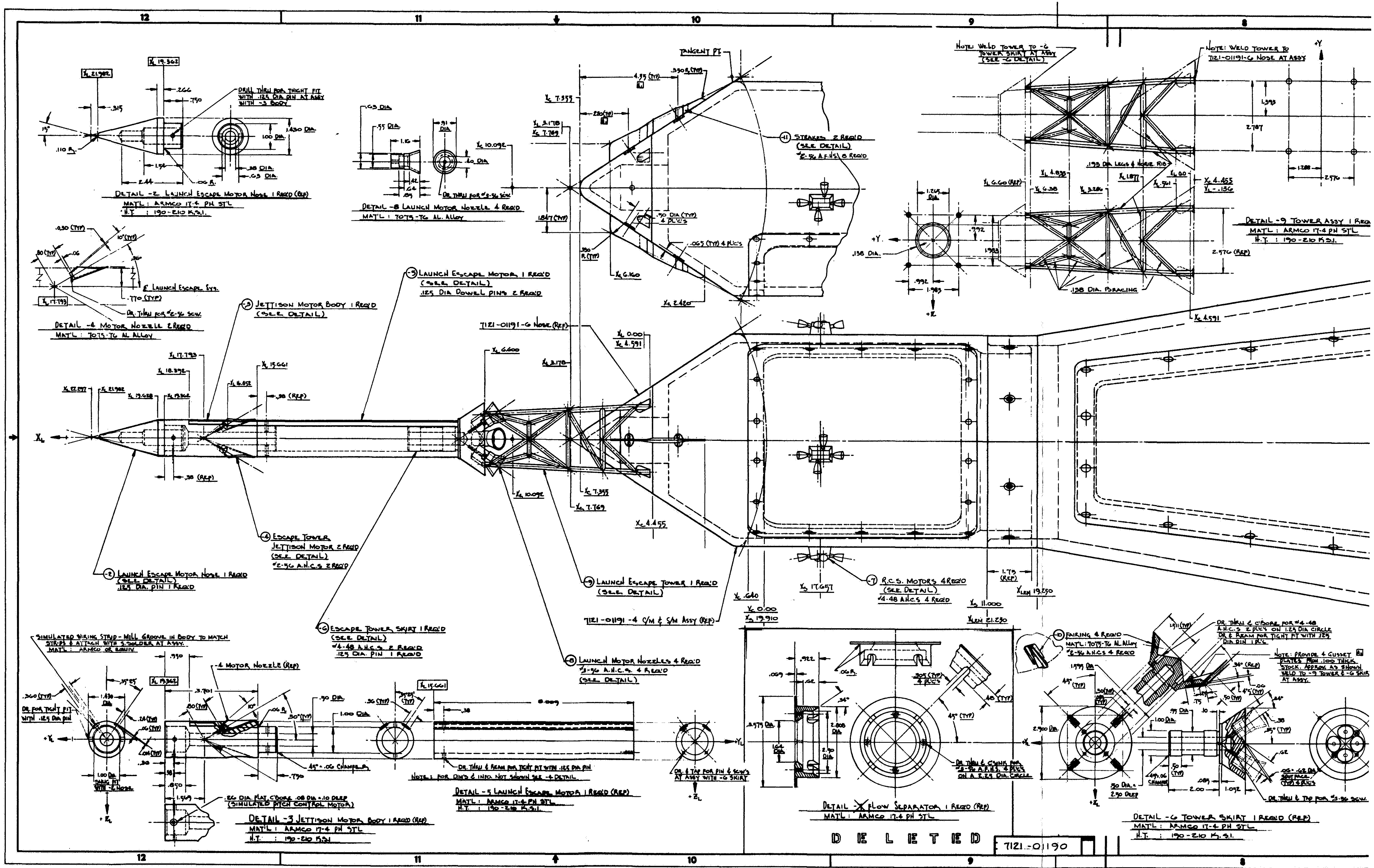
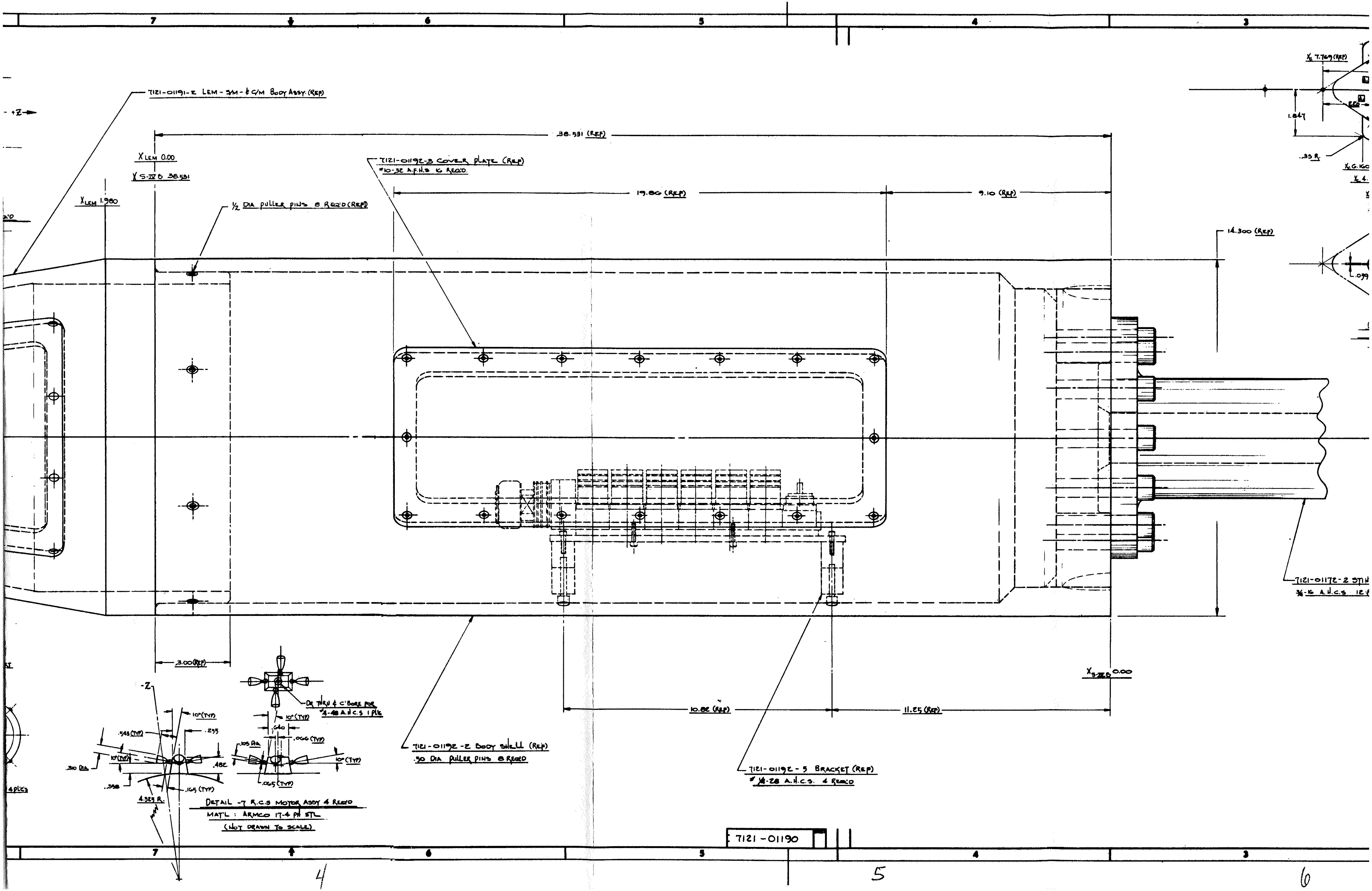


Figure 1. Configuration Sketch


DETAIL -2 LAUNCH ESCAPE MOTOR NOSE 1 REQ'D (REF)
MAT'L : ARMCO 17-4 PH STL
H.T. : 190-210 K.S.I.
DRILL THRU FOR TIGHT FIT WITH .125 DIA PIN AT ASSY WITH -3 BODY
DETAIL -8 LAUNCH MOTOR NOZZLE 4 REQ'D
MAT'L : 7075-T6 AL. ALLOY
DETAIL -4 MOTOR NOZZLE 2 REQ'D
MAT'L : 7075-T6 AL. ALLOY
℄ LAUNCH ESCAPE SYS.
TANGENT PT
STRAKES 2 REQ'D (SEE DETAIL)
NOTE: WELD TOWER TO -6 TOWER SKIRT AT ASSY (SEE -6 DETAIL)
NOTE: WELD TOWER TO 7121-01191-6 NOSE AT ASSY
DETAIL -9 TOWER ASSY 1 REQ'D
MAT'L : ARMCO 17-4 PH STL
H.T. : 190-210 K.S.I.
.138 DIA. BRACING
-5 LAUNCH ESCAPE MOTOR, 1 REQ'D (SEE DETAIL) .125 DIA DOWEL PINS 2 REQ'D
-3 JETTISON MOTOR BODY 1 REQ'D (SEE DETAIL)
7121-01191-6 NOSE (REF)
-4 ESCAPE TOWER JETTISON MOTOR 2 REQ'D (SEE DETAIL)
-2 LAUNCH ESCAPE MOTOR NOSE 1 REQ'D (SEE DETAIL) .125 DIA. PIN 1 REQ'D
-9 LAUNCH ESCAPE TOWER 1 REQ'D (SEE DETAIL)
-7 R.C.S. MOTORS 4 REQ'D (SEE DETAIL)
7121-01191-4 C/M & S/M ASSY (REF)
-6 ESCAPE TOWER SKIRT 1 REQ'D (SEE DETAIL)
-8 LAUNCH MOTOR NOZZLES 4 REQ'D (SEE DETAIL)
SIMULATED WIRING STRIP - MILL GROOVE IN BODY TO MATCH STRIPS & ATTACH WITH S.SOLDER AT ASSY. MAT'L : ARMCO OR EQUIV.
-4 MOTOR NOZZLE (REF)
.26 DIA. FLAT C'BORE .08 DIA × .10 DEEP (SIMULATED PITCH CONTROL MOTOR)
DETAIL -3 JETTISON MOTOR BODY 1 REQ'D (REF)
MAT'L : ARMCO 17-4 PH STL
H.T. : 190-210 K.S.I.
DETAIL -5 LAUNCH ESCAPE MOTOR 1 REQ'D (REF)
MAT'L : ARMCO 17-4 PH STL
H.T. : 190-210 K.S.I.
FAIRING 4 REQ'D
MAT'L : 7075-T6 AL ALLOY
DETAIL -X FLOW SEPARATOR 1 REQ'D (REF)
MAT'L : ARMCO 17-4 PH STL
DELETED
7121-01190
DETAIL -6 TOWER SKIRT 1 REQ'D (REF)
MAT'L : ARMCO 17-4 PH STL
H.T. : 190-210 K.S.I.
NOTE: PROVIDE 4 GUSSET PLATES FROM .100 THICK STOCK. APPROX AS SHOWN WELD TO -9 TOWER & -6 SKIRT AT ASSY.
1
2
3


7121-01191-2 LEM-SM-&C/M BODY ASSY. (REF)
+Z
38.531 (REF)
X_{LEM} 0.00
X_{S-IVB} 38.531
X_{LEM} 1.980
1/2 DIA PULLER PINS 8 REQ'D (REF)
7121-01192-3 COVER PLATE (REF)
#10-32 A.F.H.S 16 REQ'D
19.80 (REF)
9.10 (REF)
14.300 (REF)
X_s 7.769 (REF)
1.847
.35 R.
3.00 (REF)
X_{S-IVB} 0.00
10.86 (REF)
11.25 (REF)
-Z
DR THRU & C'BORE FOR #4-48 A.N.C.S 1 PL'S
10° (TYP)
.255
.543 (TYP)
.640
.066 (TYP)
.105 DIA
10° (TYP)
.310 DIA
.482
.065 (TYP)
.165 (TYP)
.358
4.325 R.
DETAIL -7 R.C.S MOTOR ASSY 4 REQ'D
MAT'L : ARMCO 17-4 PH STL
(NOT DRAWN TO SCALE)
7121-01192-2 BODY SHELL (REF)
.50 DIA PULLER PINS 8 REQ'D
7121-01192-5 BRACKET (REF)
#1/4-28 A.N.C.S. 4 REQ'D
7121-01172-2 STI
3/8-16 A.N.C.S 12
7121-01190
7 6 5 4 3
4
5
6

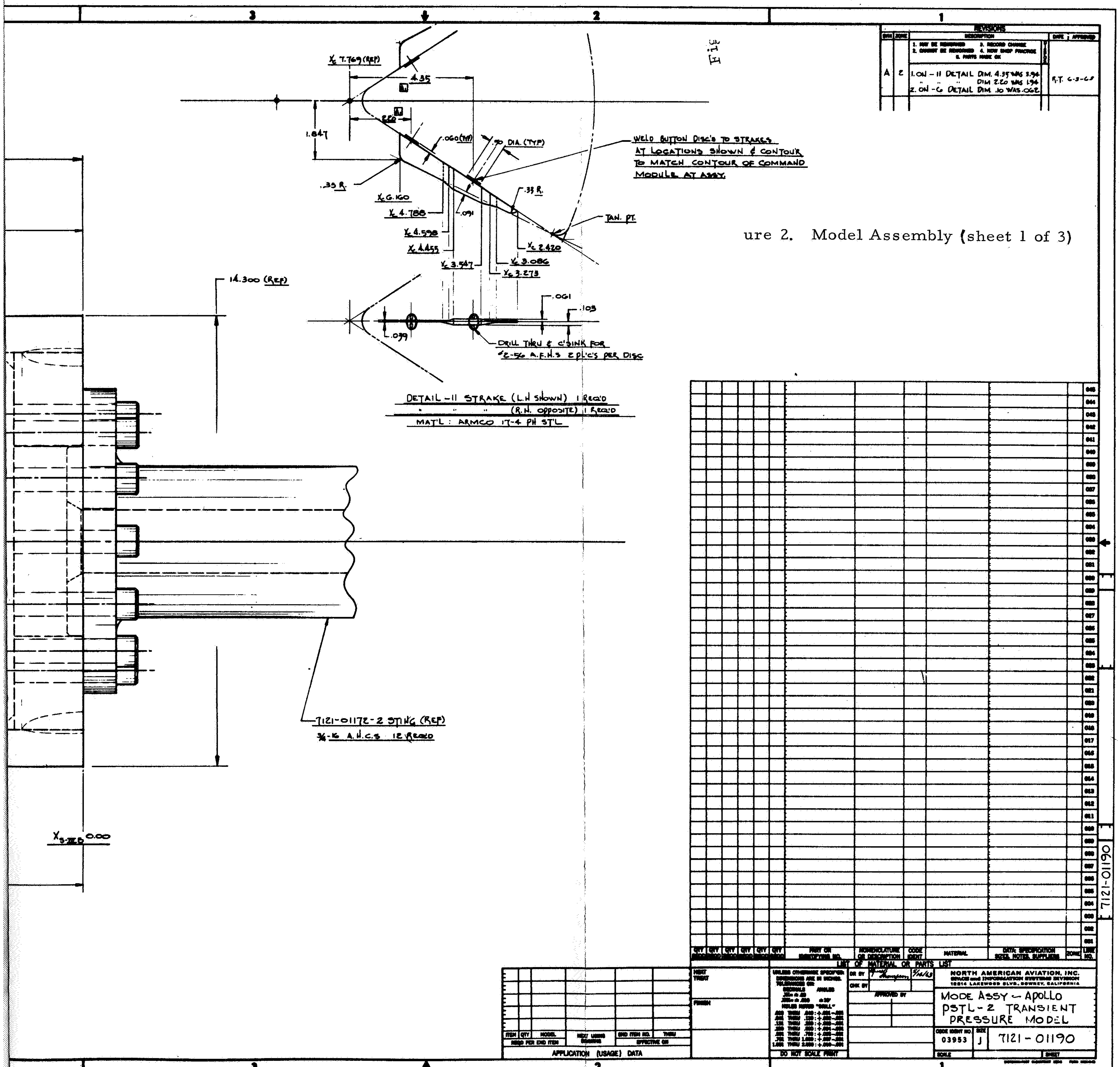
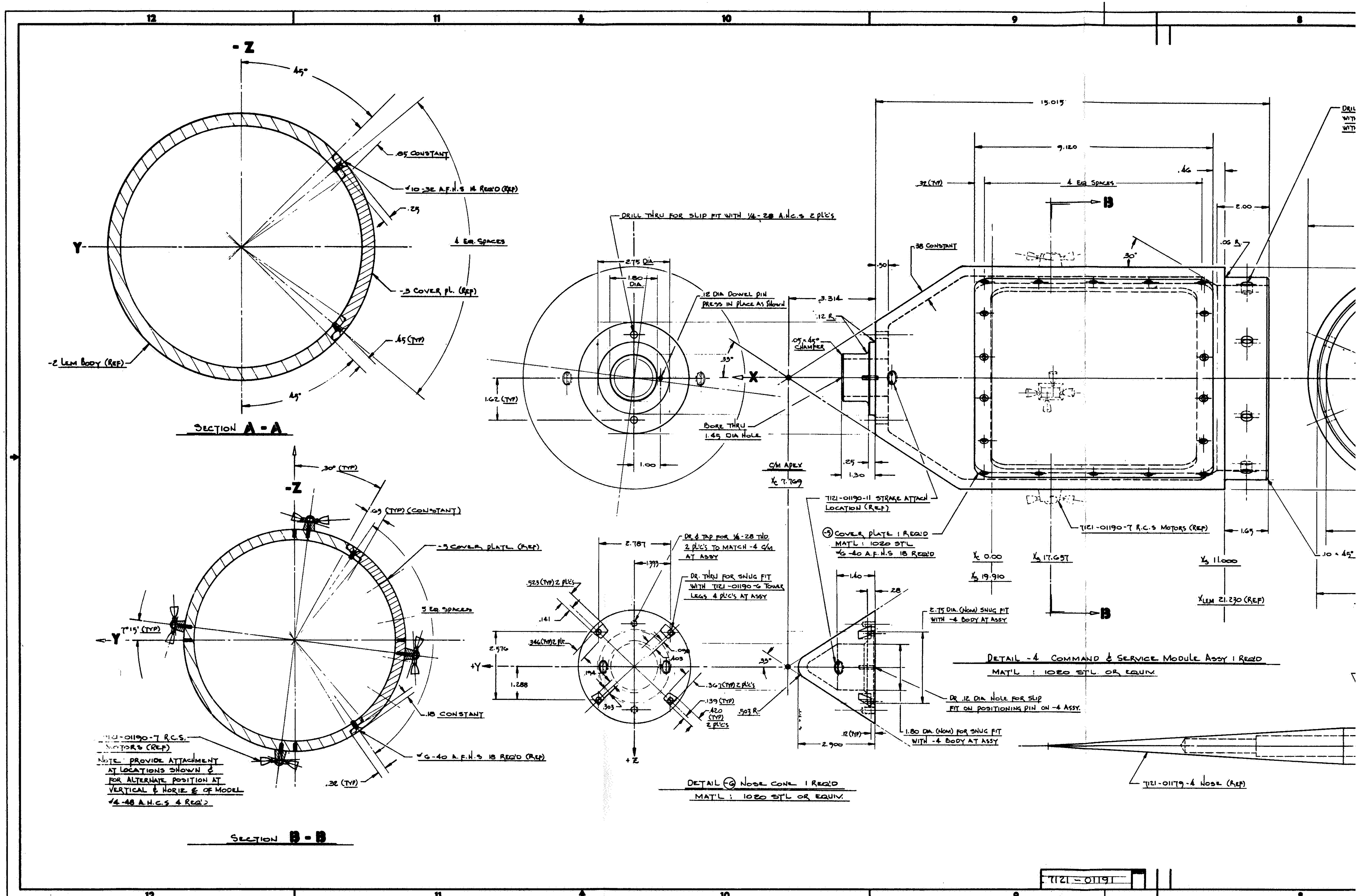
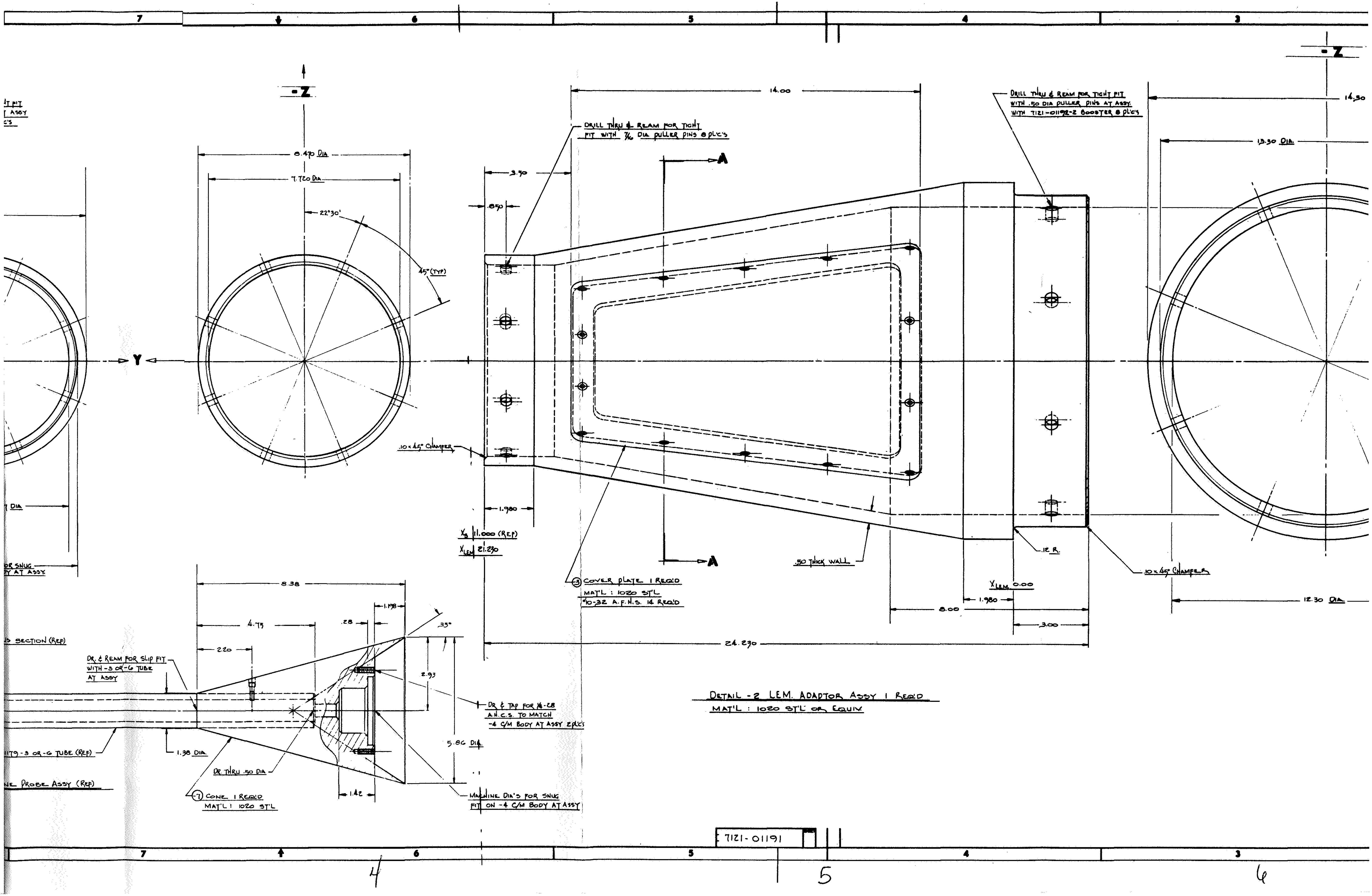


Fig ure 2. Model Assembly (sheet 1 of 3)

6



SECTION A-A
.05 CONSTANT
√10-32 A.F.H.S 14 REQ'D (REF)
.25
4 EQ. SPACES
-3 COVER PL. (REF)
.65 (TYP)
45°
-2 LEM BODY (REF)
-Z
Y
SECTION B-B
.30° (TYP)
.09 (TYP) (CONSTANT)
-3 COVER PLATE (REF)
5 EQ. SPACES
.18 CONSTANT
√6-40 A.F.H.S 18 REQ'D (REF)
.32 (TYP)
7°15' (TYP)
7121-01190-7 R.C.S. MOTORS (REF)
NOTE: PROVIDE ATTACHMENT AT LOCATIONS SHOWN & FOR ALTERNATE POSITION AT VERTICAL & HORIZ. ℄ OF MODEL
√4-48 A.H.C.S 4 REQ'D
DRILL THRU FOR SLIP FIT WITH 1/4-28 A.H.C.S 2 PL'C'S
2.75 DIA.
1.80 DIA.
.12 DIA DOWEL PIN PRESS IN PLACE AS SHOWN
BORE THRU 1.45 DIA HOLE
1.62 (TYP)
1.00
3.314
.12 R.
.05 x 45° CHAMFER
35°
X
C/M APEX
X_c 7.769
.25
1.30
.50
.38 CONSTANT
.32 (TYP)
15.015
9.120
4 EQ. SPACES
.46
2.00
.06 R.
30°
B
7121-01190-11 STRAKE ATTACH LOCATION (REF)
-5 COVER PLATE 1 REQ'D
MAT'L: 1020 ST'L
√6-40 A.F.H.S 18 REQ'D
X_c 0.00
X_s 19.910
X_s 17.657
7121-01190-7 R.C.S. MOTORS (REF)
X_s 11.000
X_{LEM} 21.230 (REF)
1.69
.10 x 45°
DR. & TAP FOR 1/4-28 THD 2 PL'C'S TO MATCH -4 C/M AT ASSY
DR. THRU FOR SNUG FIT WITH 7121-01190-6 TOWER LEGS 4 PL'C'S AT ASSY
2.787
1.393
.523 (TYP) 2 PL'C'S
.141
.346 (TYP) 2 PL'C
2.576
1.288
.194
.303
.09
.403
.367 (TYP) 2 PL'C'S
.139 (TYP)
.420 (TYP) 2 PL'C'S
.503 R.
+Y
+Z
1.40
.28
2.75 DIA. (NOM) SNUG FIT WITH -4 BODY AT ASSY
DR. .12 DIA HOLE FOR SLIP FIT ON POSITIONING PIN ON -4 ASSY.
1.80 DIA. (NOM) FOR SNUG FIT WITH -4 BODY AT ASSY
.12 (TYP)
2.900
DETAIL -6 NOSE CONE 1 REQ'D
MAT'L: 1020 ST'L OR EQUIV.
DETAIL -4 COMMAND & SERVICE MODULE ASSY 1 REQ'D
MAT'L: 1020 ST'L OR EQUIV.
7121-01179-4 NOSE (REF)
7121-01191
12
11
10
9
8
1
2


-Z
14.00
DRILL THRU & REAM FOR TIGHT FIT WITH .50 DIA PULLER PINS AT ASSY. WITH 7121-01192-2 BOOSTER 8 PL'C'S
14.30
13.30 DIA
8.470 DIA
7.720 DIA
22°30'
45° (TYP)
DRILL THRU & REAM FOR TIGHT FIT WITH 7/16 DIA PULLER PINS 8 PL'C'S
3.90
.850
A
Y
.10 x 45° CHAMFER
1.980
X_B 11.000 (REF)
X_{LEM} 21.290
3 COVER PLATE 1 REQ'D
MAT'L : 1020 ST'L
#10-32 A.F.H.S. 14 REQ'D
.50 THICK WALL
.12 R.
.10 x 45° CHAMFER
X_{LEM} 0.00
1.980
8.00
3.00
12.30 DIA
24.290
8.38
4.75
2.20
.28
1.198
.33°
2.93
5.86 DIA
1.42
DR & REAM FOR SLIP FIT WITH -3 OR -6 TUBE AT ASSY
DR & TAP FOR 1/4-28 A.H.C.S. TO MATCH -4 C/M BODY AT ASSY 2 PL'C'S
1.38 DIA
DR THRU .50 DIA
7 CONE 1 REQ'D
MAT'L : 1020 ST'L
MACHINE DIA'S FOR SNUG FIT ON -4 C/M BODY AT ASSY
SECTION (REF)
1179-3 OR-6 TUBE (REF)
NE PROBE ASSY (REF)
OR SNUG
Y AT ASSY
DIA
DETAIL - 2 LEM. ADAPTOR ASSY 1 REQ'D
MAT'L : 1020 ST'L OR EQUIV
7121-01191
7
6
5
4
3
4
5
6

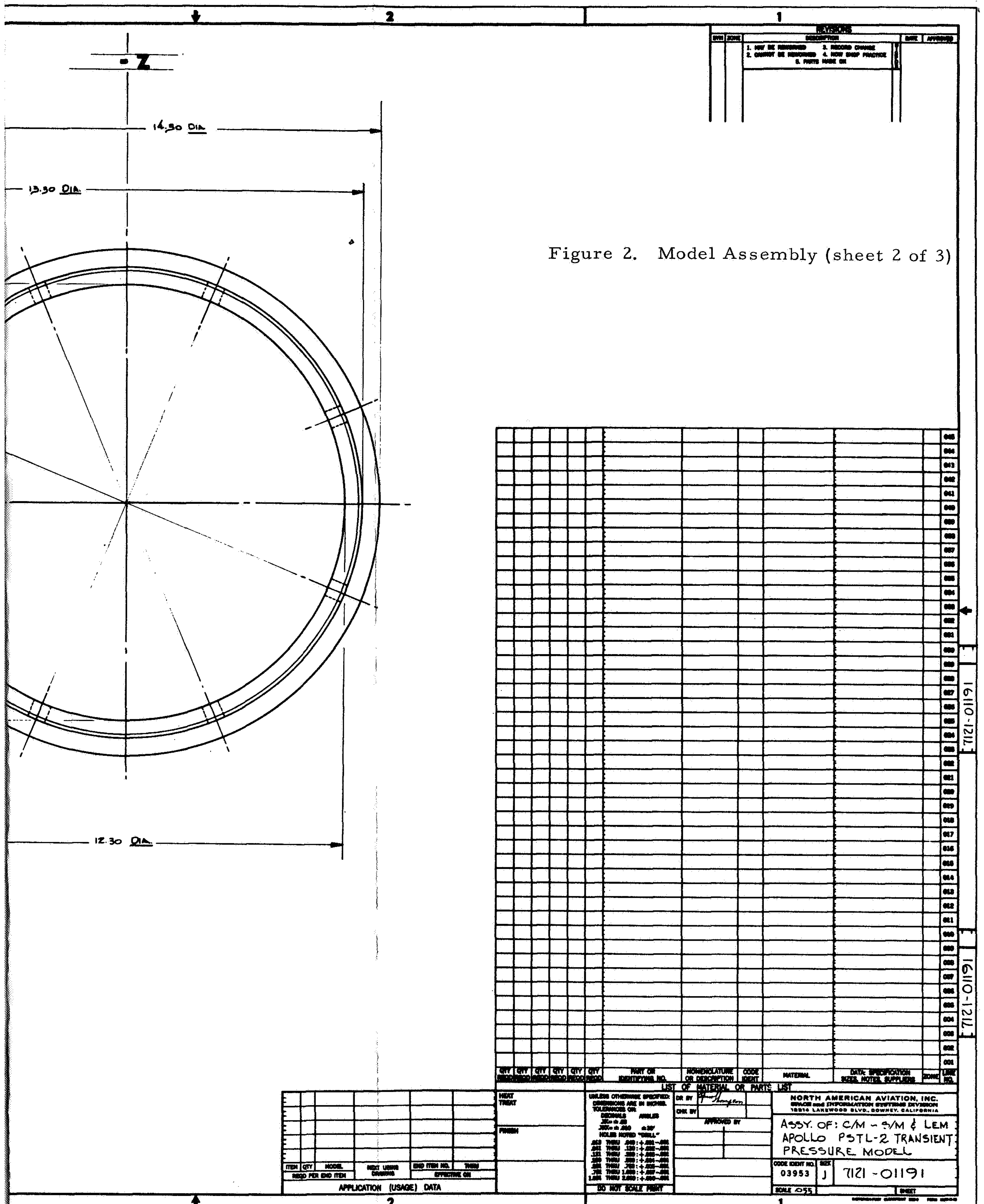
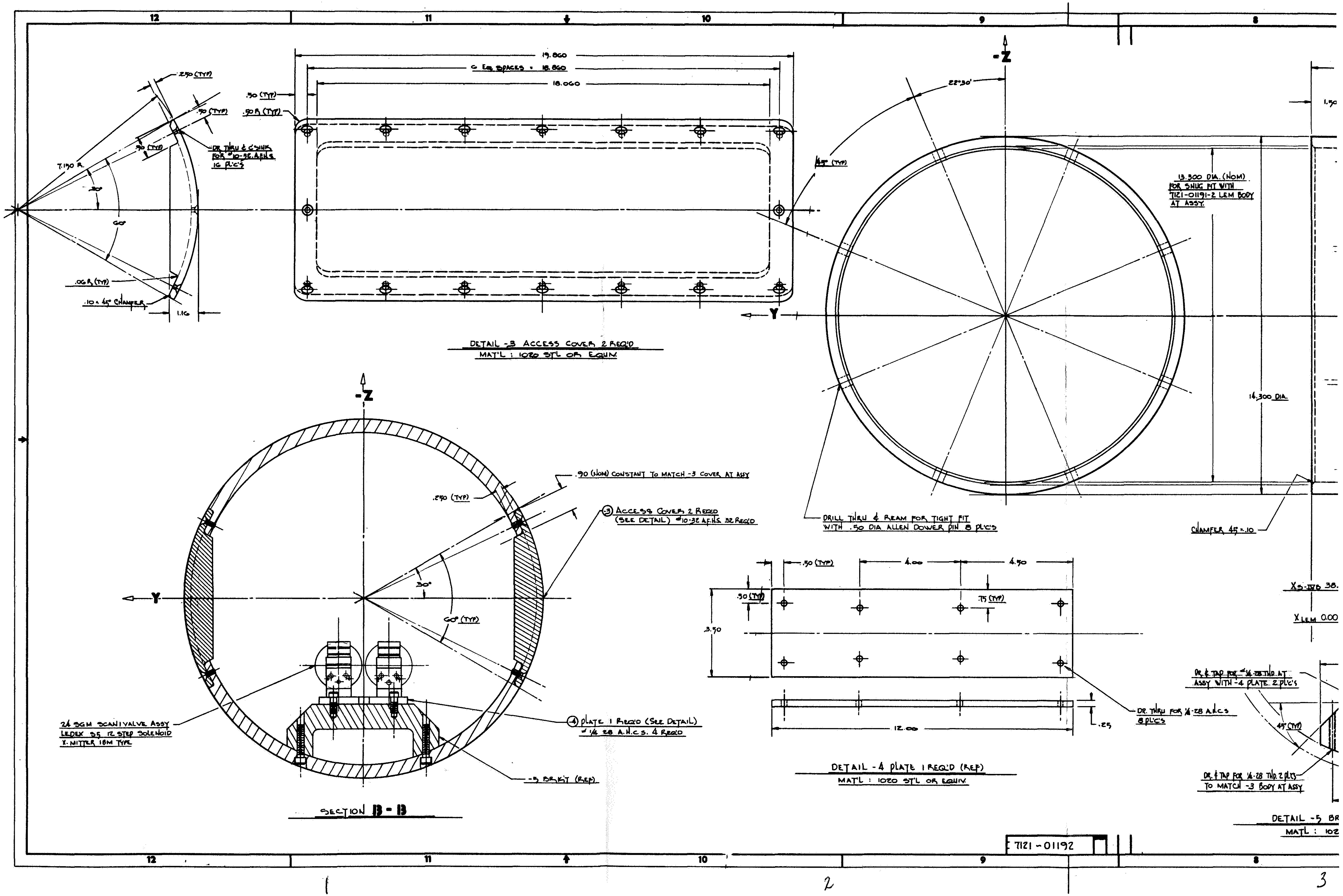
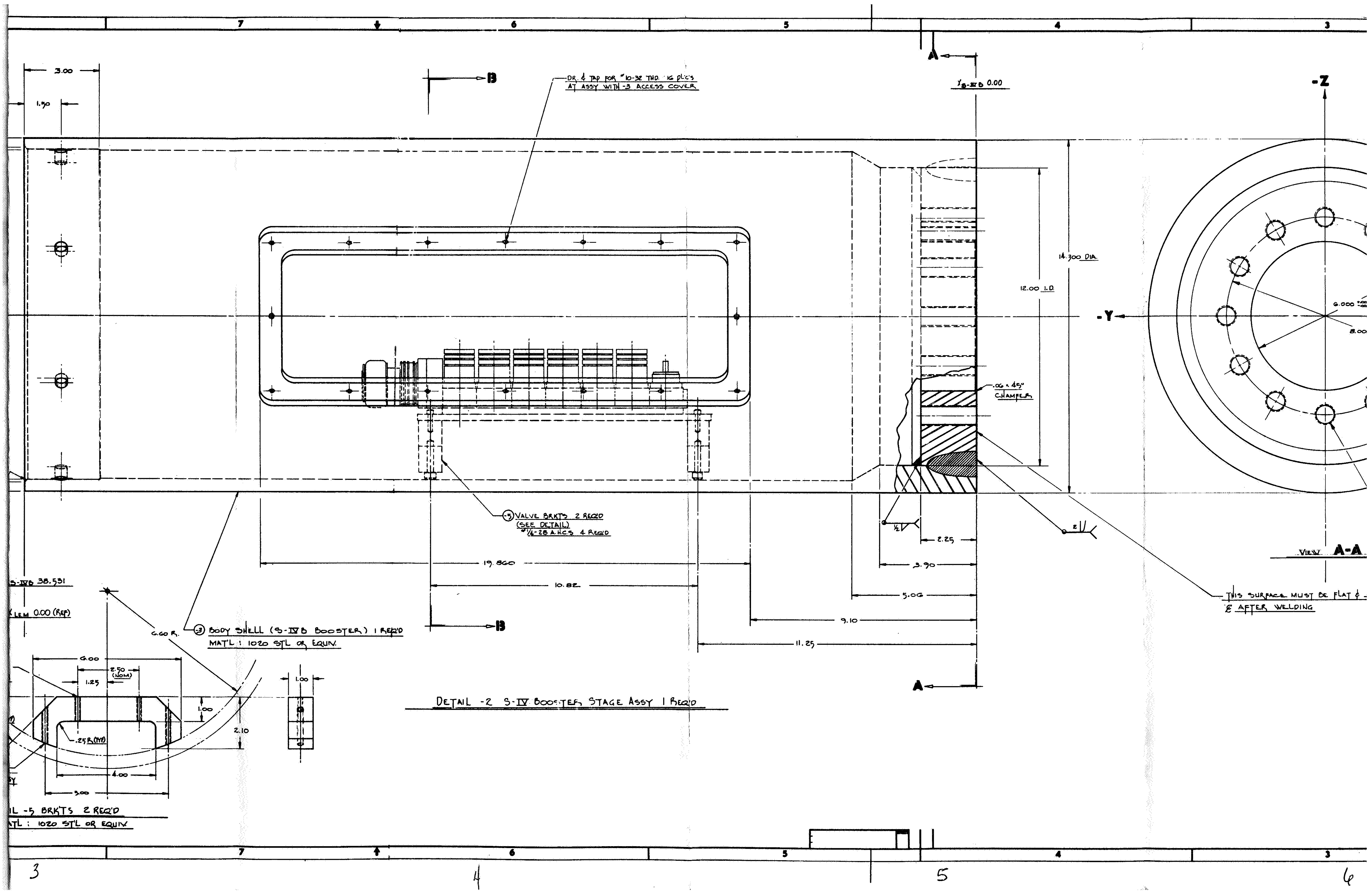


Figure 2. Model Assembly (sheet 2 of 3)



DETAIL -3 ACCESS COVER 2 REQ'D
MAT'L : 1020 STL OR EQUIV.
19.860
6 EQ SPACES = 18.860
18.060
.50 (TYP)
.50 R (TYP)
.250 (TYP)
.90 (TYP)
7.190 R.
30°
60°
.06 R (TYP)
.10 x 45° CHAMFER
1.16
DR THRU & C'SINK FOR #10-32 A.F.H.S. 16 PLC'S
45° (TYP)
22°30'
-Z
Y
13.300 DIA. (NOM) FOR SNUG FIT WITH 7121-01191-2 LEM BODY AT ASSY.
14.300 DIA.
1.50
DRILL THRU & REAM FOR TIGHT FIT WITH .50 DIA ALLEN DOWEL PIN 8 PLC'S
CHAMFER 45° x .10
XS-376 38.
XLEM 0.00
.90 (NOM) CONSTANT TO MATCH -3 COVER AT ASSY
.250 (TYP)
-3 ACCESS COVER 2 REQ'D (SEE DETAIL) #10-32 A.F.H.S. 32 REQ'D
30°
60° (TYP)
24 SGM SCANIVALVE ASSY LEDEX S5 12 STEP SOLENOID X. MITTER 18M TYPE
-4 PLATE 1 REQ'D (SEE DETAIL) #1/4 28 A.H.C.S. 4 REQ'D
-5 BRK'T (REF)
SECTION B - B
.50 (TYP)
4.00
4.50
.75 (TYP)
3.50
12.00
.25
DR. THRU FOR 1/4-28 A.H.C.S 8 PLC'S
DETAIL -4 PLATE 1 REQ'D (REF)
MAT'L : 1020 STL OR EQUIV.
DR. & TAP FOR #1/4-28 THD AT ASSY WITH -4 PLATE 2 PLC'S
45° (TYP)
DR. & TAP FOR 1/4-28 THD 2 PLCS TO MATCH -3 BODY AT ASSY
DETAIL -5 BR
MATL : 102
7121 - 01192
12
11
10
9
8
1
2
3



DR. & TAP FOR #10-32 THD. 16 PLC'S AT ASSY WITH -3 ACCESS COVER
Y S-IVB 0.00
-Z
-Y
14.300 DIA.
12.00 I.D.
.06 x 45° CHAMFER
-5 VALVE BRKTS 2 REQ'D (SEE DETAIL) #1/4-28 A.H.C.S. 4 REQ'D
19.860
10.82
2.25
3.90
5.06
9.10
11.25
3.00
1.50
S-IVB 38.531
LEM 0.00 (REF)
6.60 R.
-3 BODY SHELL (S-IVB BOOSTER) 1 REQ'D
MAT'L: 1020 STL OR EQUIV.
6.00
2.50 (NOM)
1.25
1.00
2.10
.25 R (TYP)
4.00
3.00
DETAIL -2 S-IV BOOSTER STAGE ASSY 1 REQ'D
VIEW A-A
THIS SURFACE MUST BE FLAT & ⊥ TO ℄ AFTER WELDING
IL -5 BRKTS 2 REQ'D
ATL: 1020 STL OR EQUIV
6.000
8.00
A
B
3
4
5
6

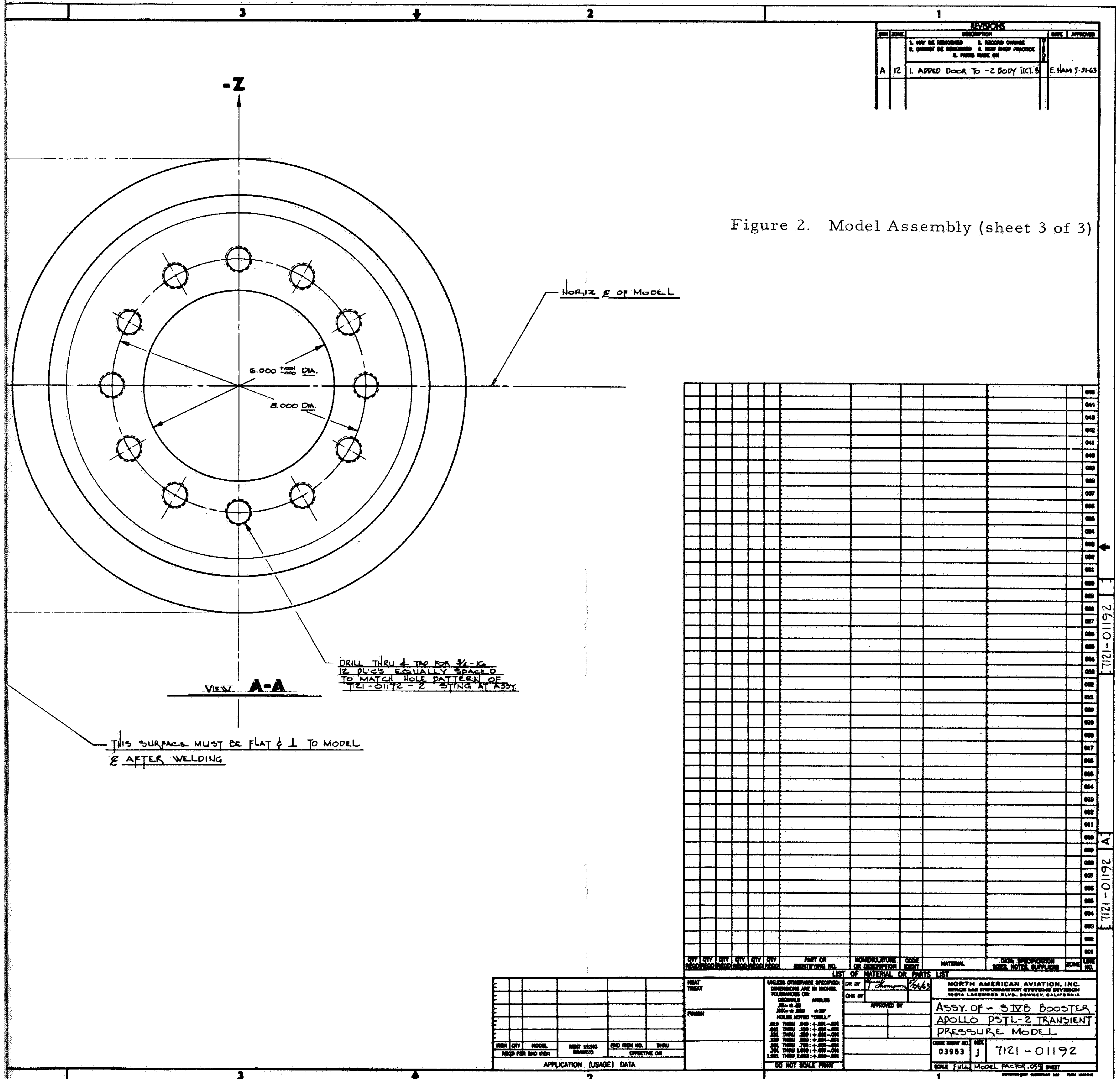
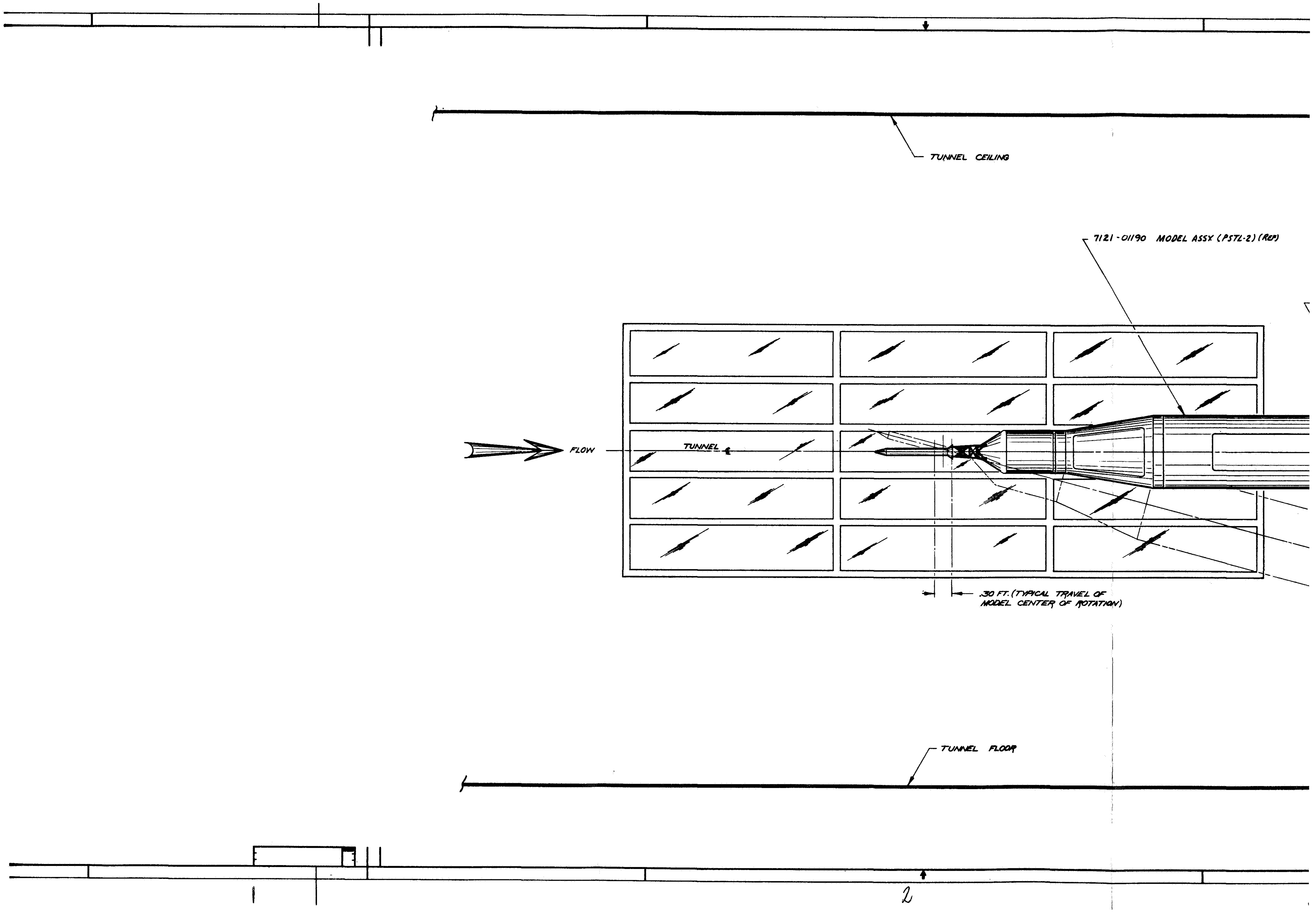


Figure 2. Model Assembly (sheet 3 of 3)



TUNNEL CEILING
7121-01190 MODEL ASSY (PSTL-2) (REF)
FLOW
TUNNEL ℄
.30 FT. (TYPICAL TRAVEL OF MODEL CENTER OF ROTATION)
TUNNEL FLOOR
2

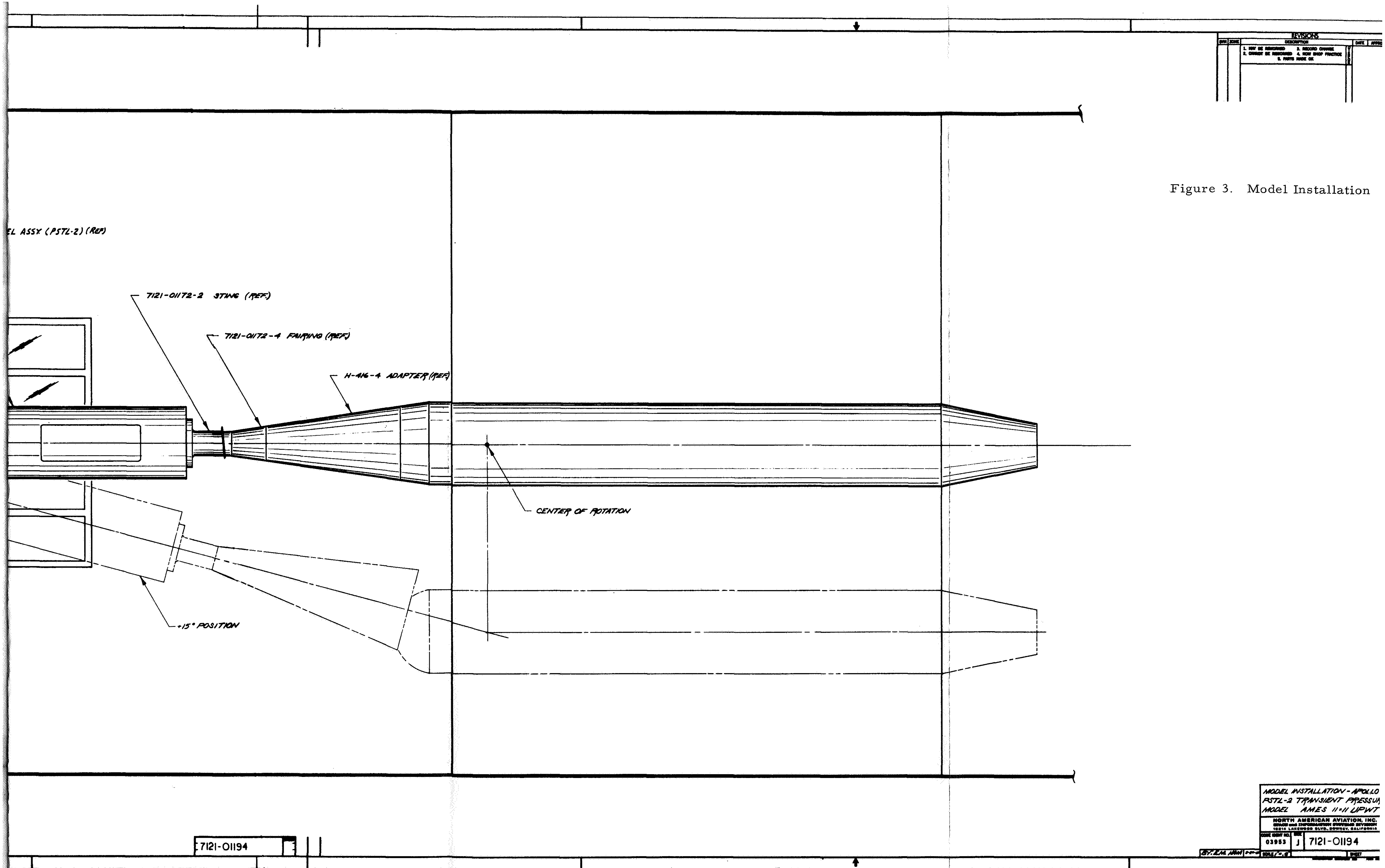


Figure 3. Model Installation

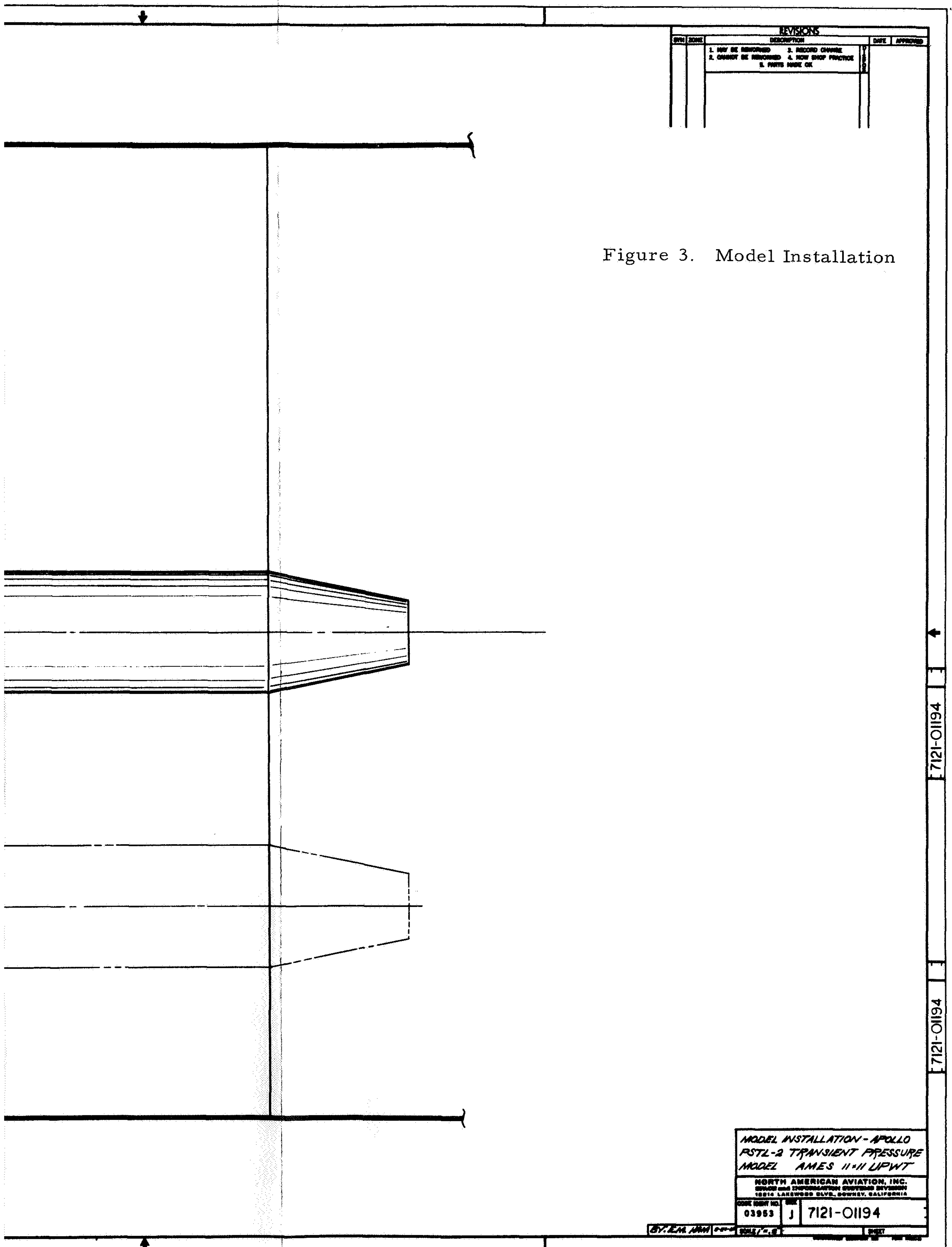
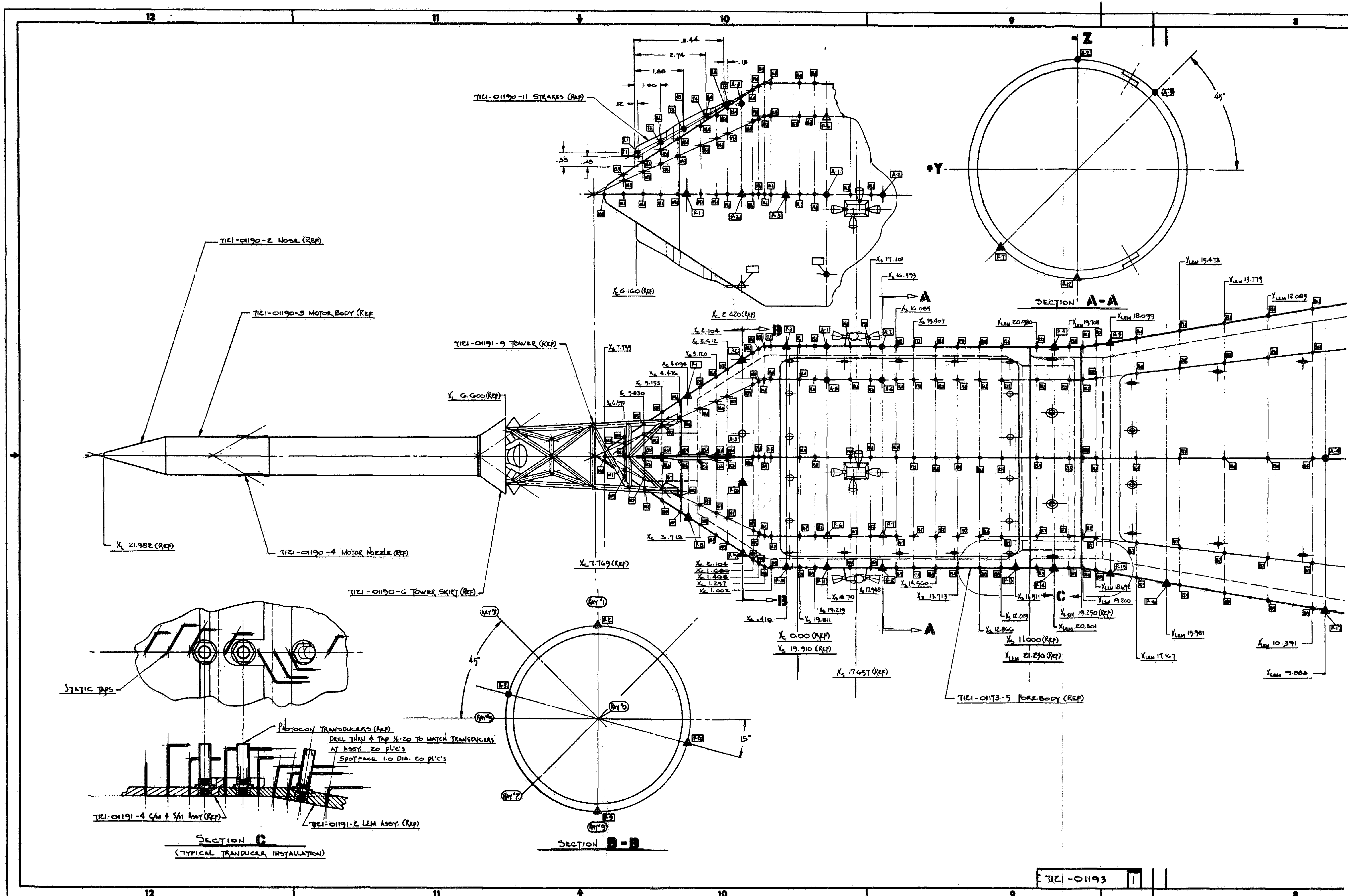


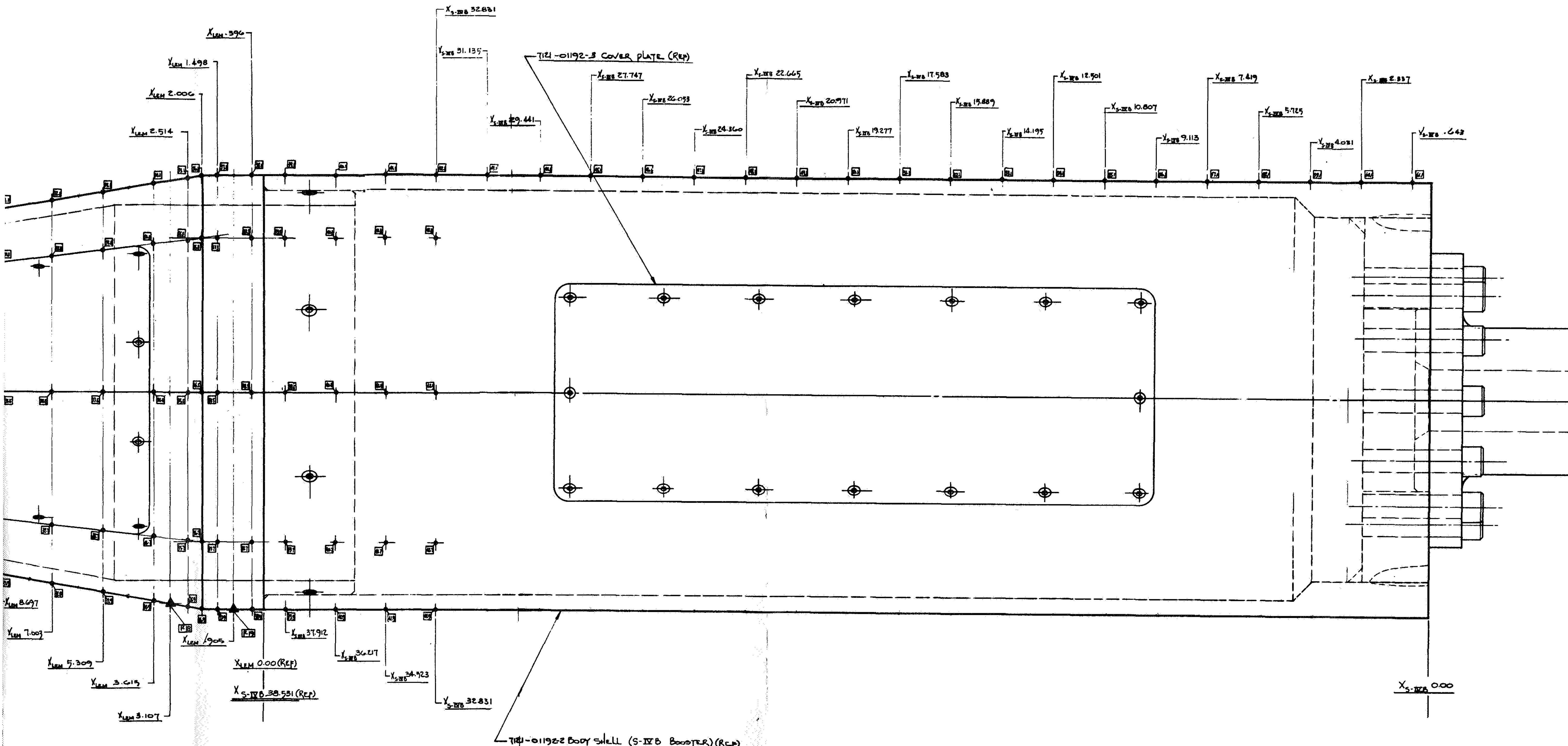
Figure 3. Model Installation



7121-01190-11 STRAKES (REF)
7121-01190-2 NOSE (REF)
7121-01190-3 MOTOR BODY (REF
7121-01191-9 TOWER (REF)
7121-01190-4 MOTOR NOZZLE (REF)
7121-01190-6 TOWER SKIRT (REF)
7121-01173-5 FOREBODY (REF)
SECTION A-A
SECTION B-B
STATIC TAPS
PHOTOCON TRANSDUCERS (REF)
DRILL THRU & TAP ¼-20 TO MATCH TRANSDUCERS
AT ASSY. 20 PL'C'S
SPOTFACE 1.0 DIA. 20 PL'C'S
7121-01191-4 C/M & S/M ASSY (REF)
7121-01191-2 LEM. ASSY. (REF)
SECTION C
(TYPICAL TRANDUCER INSTALLATION)
7121-01193

1

2



STATIC TAP LOCATION	X/D DIM	DIM STA
0	0.0	
1	.09	
2	.180	
3	.260	
4	.340	
5	.385	
•	.430	
6	.50	
7	.56	
•	.62	
8	.67	
9	.695	
10	.720	
11	.750	
•	.820	
12	.880	
13	.950	
•	1.010	
14	1.100	
15	1.200	
•	1.260	
16	1.320	
17	1.400	
18	1.500	
19	1.600	
20	1.700	
21	1.800	
•	1.860	
22	1.950	
•	2.030	
23	2.100	
24	2.160	
25	2.220	
•	2.290	

▲ PHOTO
● ALANTI
• STATIC

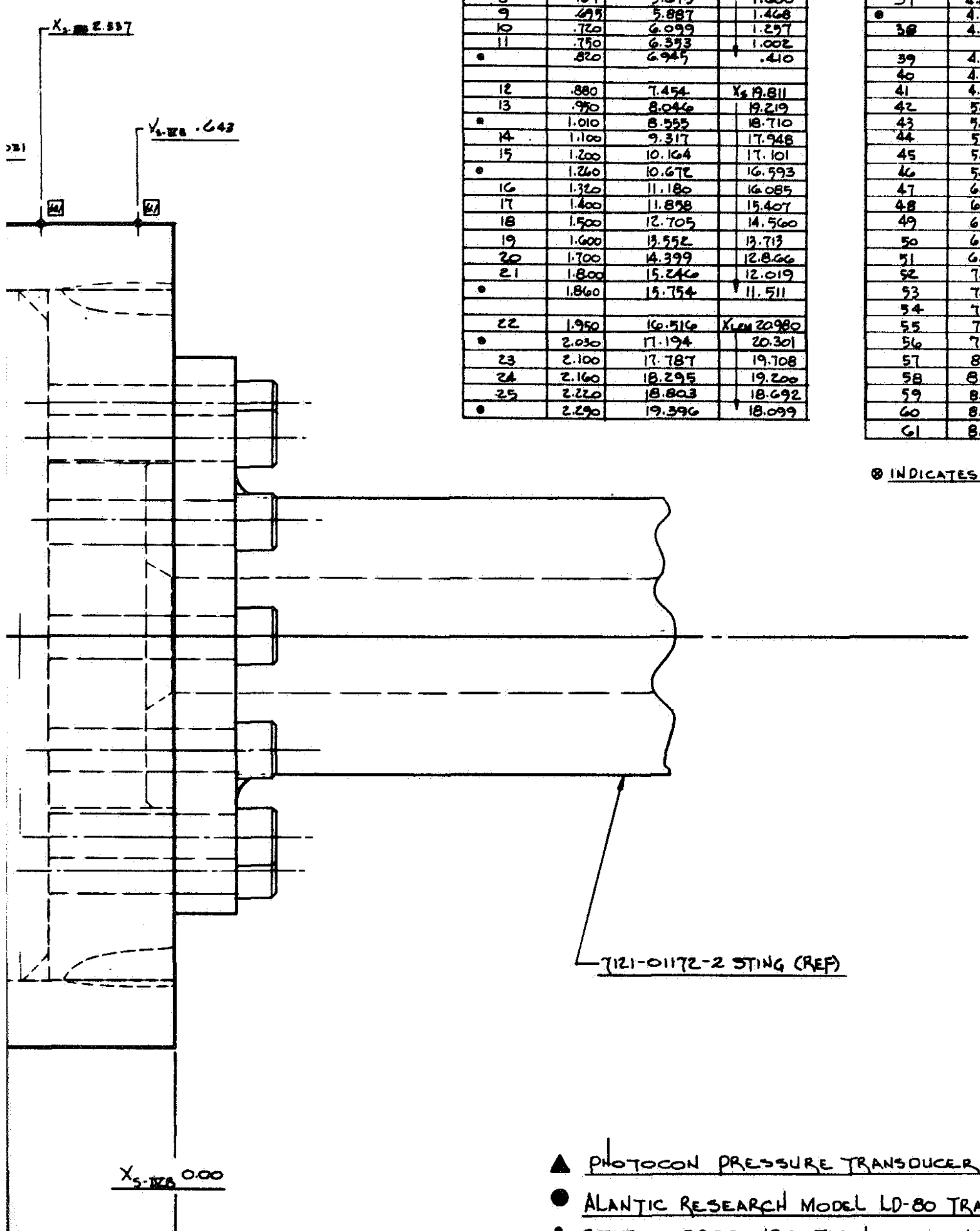
FIRST TW LAST DI
P-3 OR A-1 INDICAT
T-1 OR B-1 INDICAT ALL STAT

7121-01193 1

4

5

6



STATIC TAP LOCATION	X/D DIM	DIM. AFT OF STA X_C 7.355	MODEL STA.
0	0.0	0.00	X_C 7.355
1	.09	.762	6.939
2	.180	1.525	5.830
3	.260	2.202	5.153
4	.340	2.899	4.476
5	.385	3.261	4.094
●	.430	3.642	3.713
6	.50	4.235	3.120
7	.56	4.743	2.612
●	.62	5.251	2.104
8	.67	5.675	1.680
9	.695	5.887	1.468
10	.720	6.099	1.257
11	.750	6.353	1.002
●	.820	6.945	.410
12	.880	7.454	X_S 19.811
13	.950	8.046	19.219
●	1.010	8.555	18.710
14	1.100	9.317	17.948
15	1.200	10.164	17.101
●	1.260	10.672	16.593
16	1.320	11.180	16.085
17	1.400	11.858	15.407
18	1.500	12.705	14.560
19	1.600	13.552	13.713
20	1.700	14.399	12.866
21	1.800	15.246	12.019
●	1.860	15.754	11.511
22	1.950	16.516	X_{LEM} 20.980
●	2.030	17.194	20.301
23	2.100	17.787	19.708
24	2.160	18.295	19.200
25	2.220	18.803	18.692
●	2.290	19.396	18.099
26	2.400	20.328	X_{LEM} 17.167
●	2.54	21.514	15.981
27	2.60	22.022	15.473
28	2.80	23.716	13.779
29	3.00	25.410	12.085
30	3.20	27.104	10.391
●	3.26	27.612	9.883
31	3.40	28.798	8.697
32	3.60	30.492	7.003
33	3.80	32.186	5.309
34	4.00	33.880	3.615
●	4.06	34.388	3.107
35	4.13	34.981	2.514
36	4.19	35.489	2.006
37	4.25	35.997	1.498
●	4.32	36.590	.905
38	4.38	37.099	.396
39	4.50	38.115	$Y_{S\,1028}$ 37.912
40	4.70	39.809	36.217
41	4.90	41.503	34.523
42	5.10	43.197	32.831
43	5.30	44.891	31.135
44	5.50	46.585	29.441
45	5.70	48.279	27.747
46	5.90	49.973	26.053
47	6.10	51.667	24.360
48	6.30	53.361	22.665
49	6.50	55.055	20.971
50	6.70	56.749	19.277
51	6.90	58.443	17.583
52	7.10	60.137	15.889
53	7.30	61.831	14.195
54	7.50	63.525	12.501
55	7.70	65.219	10.807
56	7.90	66.913	9.113
57	8.10	68.607	7.419
58	8.30	70.301	5.725
59	8.50	71.995	4.031
60	8.70	73.689	2.337
61	8.90	75.383	.643

⊗ INDICATES TRANSDUCER LOCATION

Figure 4 Model Instrumentation

▲ PHOTOCON PRESSURE TRANSDUCER
● ALANTIC RESEARCH MODEL LD-80 TRANSDUCERS
• STATIC PRESSURE TAP LOCATIONS

[004] FIRST TWO DIGITS INDICATE STATIC TAP STATION NUMBER
LAST DIGIT DENOTES RAY (SEE SECT. B-B)

[P-3] OR [A-1] INDICATES TRANSDUCER & NUMBER

[T-1] OR [B-1] INDICATES TOP OR BOTTOM TAP ON STRAKE

ALL STATIC TAPS TO BE .095 x .065 S.S TUBING

REVISIONS

SYM	ZONE	DESCRIPTION	DATE	APPROVED
A	4-12	1. RELOCATED INSTR. TAP LOCATIONS		
	3	2. ADDED TABULATED DIM'S		
	12	3 ADDED SECT. "C"	RT 6-3-63	

LIST OF MATERIAL OR PARTS LIST

NORTH AMERICAN AVIATION, INC.
12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA

INSTRUMENTATION ASSY.
APOLLO - PSTL-2
TRANSIENT PRESSURE MODEL

CODE IDENT NO. 03953 SIZE J 7121-01193

SCALE .035

DO NOT SCALE PRINT

APPLICATION (USAGE) DATA

6

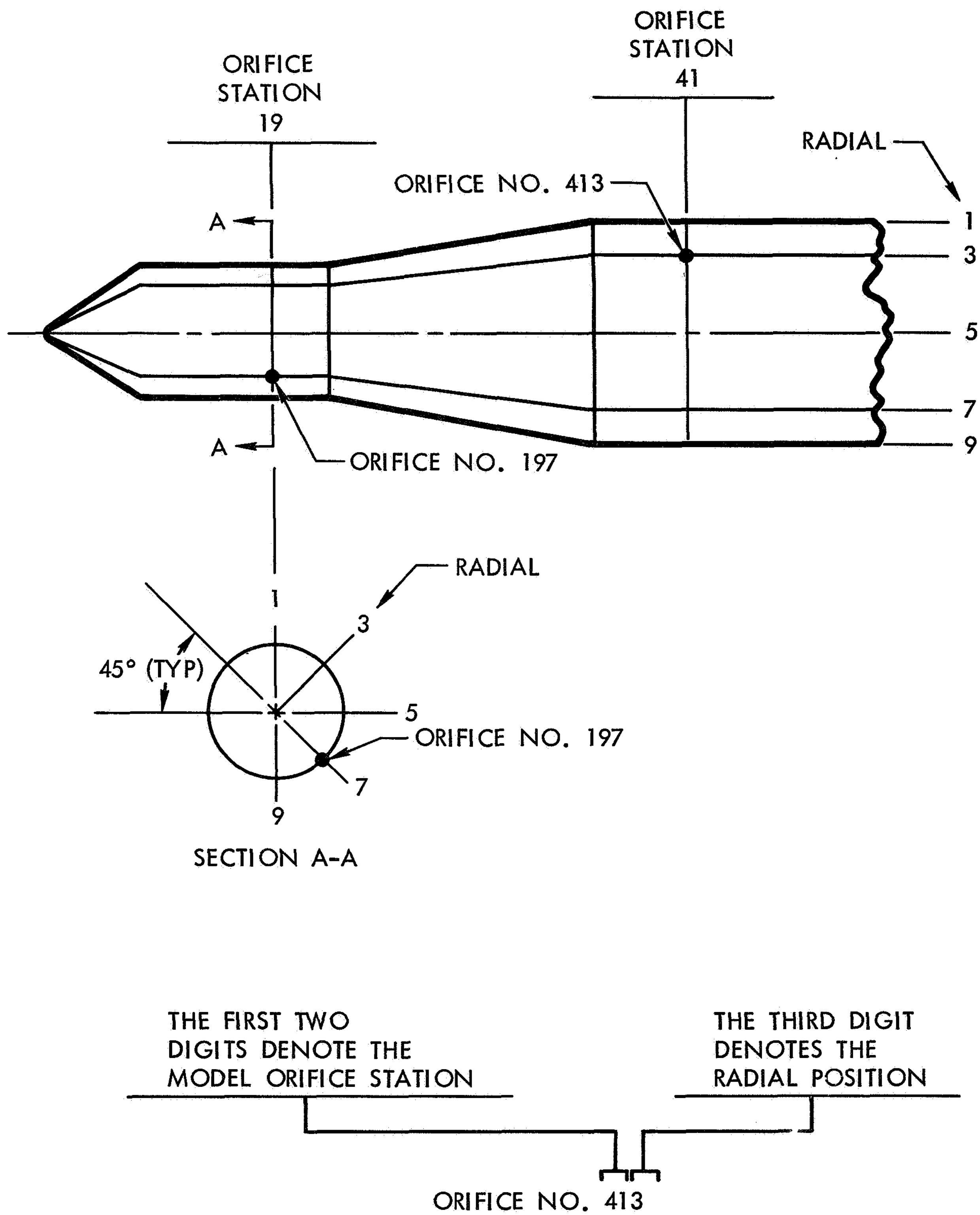
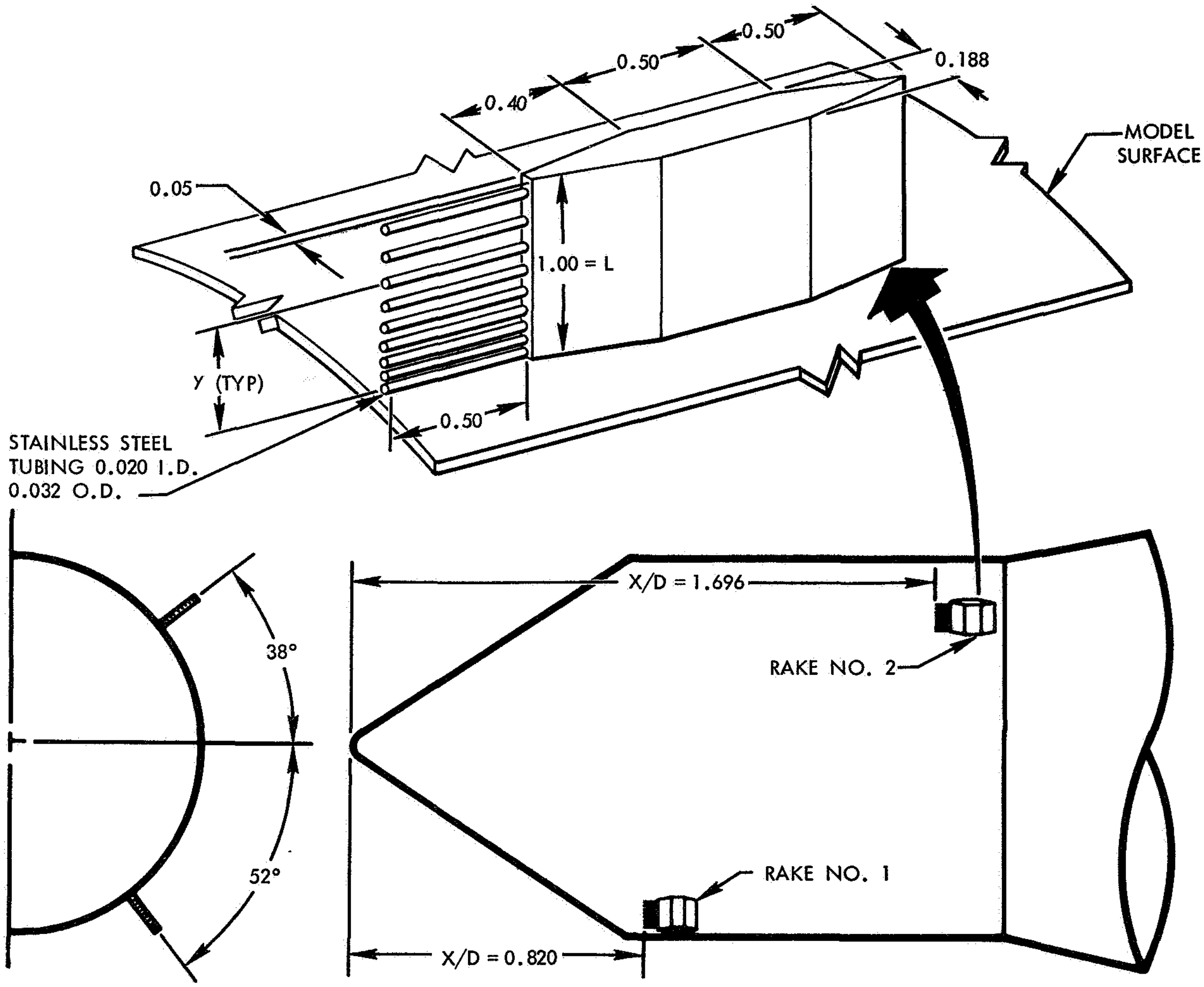


Figure 5. Orifice Numbering System



RAKE	X/D	ϕ	Y/L	ORIFICE NO.
1	0.820	218°	0.020	R11
			0.080	R12
			0.140	R13
			0.200	R14
			0.300	R15
			0.400	R16
			0.550	R17
			0.700	R18
1	0.820	218°	0.900	R19
2	1.696	308°	0.020	R21
			0.080	R22
			0.140	R23
			0.200	R24
			0.300	R25
			0.400	R26
			0.550	R27
			0.700	R28
2	1.696	308°	0.900	R29

Figure 6. Boundary Layer Rakes